RESPONSE ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR THREATENED RELEASE OF HAZARDOUS SUBSTANCES IN EPA REGION VIII

PHASE II SAMPLING AND ANALYSIS PLAN FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY OF CALCASIEU ESTUARY COOPERATIVE SITE LAKE CHARLES, LOUISIANA

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
As	Arsenic
ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
BERA	Baseline Ecological Risk Assessment
BFI	Browning-Ferris Industries
bgs	Below ground surface
BOD	Biological Oxygen Demand
CDF	Confined Disposal Facility
CDM Federal	CDM Federal Programs Corporation
CEC	Cation Exchange Capacity
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
cfs	Cubic feet per second
CLP	Contract Laboratory Program
cm	Centimeter
CN	Cyanide
CO	Contract Officer
COPC	Contaminant of Potential Concern
COD	Chemical Oxygen Demand
CRDL	Contract Required Detection Limit
CRQL	Contract Required Quantitation Limit
Cu	Copper
DO	Dissolved Oxygen
DQOs	Data Quality Objectives
EDD	Electronic Data Deliverable
Eh	Electronic (or oxidation/reduction) Potential
EPA	U. S. Environmental Protection Agency (Region 6)
ERA	Ecological Risk Assessment
ERM	Effects Range Median
ERM-Q	Effects Range Median - Quotient
FIELDS	Fully-Integrated Environmental Location Decision Support (software)
FS	Feasibility Study
FSP	Field Sampling Plan
ft	Feet
GIWW	Gulf Intracoastal Waterway

gpm	Gallons per minute
GPS	Global Positioning System
HASP	Health and Safety Plan
Hg	Mercury
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System
I-10	Interstate Highway 10
I-210	Interstate Highway 210
IDW	Investigation-derived waste
in	Inch
K	Hydraulic Conductivity
L	Liter
LCS/LCSD	Laboratory Control Sample/Laboratory Control Sample Duplicate
LDEQ	Louisiana Department of Environmental Quality
LGS	Louisiana Geological Society
m	Meters
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
mg/L	Milligrams per Liter
msl	Mean sea level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
mV	Millivolt
NGD 83	National Geodetic Datum of 1983
NGVD	National Geodetic Vertical Datum
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollution Discharge Elimination System
NPL	National Priorities List
NS&T	National Status and Trends Program
NTU	Nephelometric Turbidity Unit
NWS	National Weather Service
ORP	Oxidation reduction potential
PARCC	Precision, Accuracy, Representativeness, Completeness,

ACRONYMS AND ABBREVIATIONS (continued)

	and Comparability
Pb	Lead
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PO	Project Officer
PPE	Personal Protective Equipment
PPG	Pittsburgh Paint and Glass Industries, Inc.
ppm	Parts per million
ppt	Parts per thousand
PRC	PRC Environmental Management, Inc.
PRP	Potentially Responsible Party
psi	Pounds per square inch
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RAC	Response Action Contract
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
RPD	Relative Percent Difference
RTI	Research Triangle Institute
SAP	Sampling and Analysis Plan
SNWR	Sabine National Wildlife Refuge
SOP	Standard Operating Procedure
SOW	Statement of Work
SQG	Sediment Quality Guidelines
SVOC	Semivolatile Organic Compound
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids

ACRONYMS AND ABBREVIATIONS (continued)

USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
WAM	Work Assignment Manager
WHO	World Health Organization
±	Plus or minus
%R	Percent recovery
°C	Degrees Celsius
°F	Degrees Fahrenheit
µohm/cm	Microhm per centimeter
µg/Kg	Micrograms per Kilogram
µg/L	Micrograms per Liter

1.0 INTRODUCTION

This document is the Sampling and Analysis Plan (SAP) for Phase II of the Remedial Investigation (RI) portion of a Remedial Investigation/Feasibility Study (RI/FS) being conducted for the Calcasieu Estuary in Calcasieu Parish, Louisiana, Figure 1-1 (Preliminary figure is provided. This figure will be replaced with a final in the update.). The study area includes the Bayou d'Inde, Bayou Verdine, Upper Calcasieu River, Lower Calcasieu River. The Sabine National Wildlife Refuge (SNWR) and the Calcasieu Lake are to be used as reference areas.

The objective of the Phase II RI is to define the nature and extent of constituents [identified in Phase I] within the Estuary and to support ecological and human health risk assessments. Data will be collected to meet the Phase II objectives in four primary components: (1) Phase I data gaps, (2) ecological sediment quality triad (Triad) investigation, (3) estuary biota tissue sampling, and (4) confined disposal facility (CDF) sampling. The nature and extent and biota samples will be collected across ten sub-areas identified during evaluation of the Phase I data, as noted in Figure 1-2 (Preliminary figure is provided. Figure to be replaced with a final in the update). Data collected to satisfy the triad investigation is statistically based to provide coverage across the estuary, as noted in Figures 3-4, 3-5, and 3-6 (<u>Draft Figure 3-4 to 3-6 1 and Draft Figure 3-4 to 3-6 2</u>). CDF sampling will be conducted on a grid system, as noted on Figure 3-10.

Phase I data gap samples will be collected to address areas where samples had high detection limits, limiting interpretation of the results. Additional samples will be taken to characterize PCB results with congener analysis and to verify the characteristics of the surface water. The sediment quality Triad approach , which primarily supports ecological risk, will assess sediment toxicity, chemistry, and benthic community structure in an integrated weight of evidence approach, to link sediment chemistry to biological effects. Biota tissue sample collection will support ecological and human health risk assessments. Various species will be collected across the Estuary to represent important elements in the food web, from either an ecological or human perspective. CDF sampling will support characterization of the units. The data will be used to evaluate their current or possible future contribution to the system and ecological or human health risks. Further discussion of the entire Phase II sampling design strategy and rationale is located in section 3.0.

The Calcasieu Estuary has been divided into ten sub-areas based on the evaluation of the Phase I data, Figure 1-2 (Preliminary figure is provided. Figure is to be replaced with a final in the update.). These sub-areas include; 1-Clooney Island; 2-Clooney Island West Slip; 3-Coon Island, Northeast, 4-Coon Island Southwest, 5-Lower Bayou Verdine, 6-Upper Bayou Verdine, 7-Lower Bayou d'Inde, 8-Middle Bayou D'Inde, 9-Surge Pond, and sub-area 10-South Prien Lake. The rational for the sub-area design is discussed in section 3.0. In addition to the 10 sub-areas 11 CDFs will be investigated to determine impact to the estuary ecosystem.

The investigation of Bayou Verdine will be conducted by Conoco Incorporated. Limited Phase I RI sampling was performed at 25 locations in Bayou Verdine by CDM Federal Programs Corporation (CDM Federal). The U.S. Environmental Protection Agency (EPA) provides technical review and oversight of the Conoco sampling plans and field work. All required Phase II sampling for Bayou Verdine will be conducted by Conoco, Inc. The subject tasks are presented in the *Work Plan for the Baseline Ecological Risk Assessment (BERA) and Human Health Risk Assessment (HHRA) for the Bayou Verdine Study Area, Lake Charles, Louisiana*, prepared by ENTRIX, Inc. for Conoco Inc., April 2000.

The RI/FS for the remainder of the Calcasieu Estuary is being conducted for the U.S. EPA Region VI under the EPA Region VIII Response Action Contract (RAC) No. 68-W5-0022, Work Assignment No. 041-RI-CO-06ZZ. The RI/FS involves the investigation and characterization of organic and inorganic chemical contamination, as well as assessment of human health and ecological risk. A Feasibility Study (FS) will evaluate alternatives to mitigate risks due to unacceptable levels of environmental contaminants within the estuary. Chemical contamination, primarily from local industrial activities, has been detected in the surface water, sediment, and fish and crustacean tissue across the estuary.

This SAP describes the field investigation and support that CDM Federal will provide EPA during the conduct of Phase II of the RI. It documents the methods employed to collect surface and sub-surface sediment, surface water, soils, and biota tissue from the Calcasieu Estuary for chemical and toxicological analysis. Chemical testing will be used to further define the extent of contamination within the estuary, determine the presence or absence of chemicals in biota, and to support data needs for human health and ecological risk assessment. The sediment toxicity tests and benthic macroinvertebrate community surveys provide measurement endpoints to support the ecological risk assessment evaluation. The biota tissue sampling program includes the collection of tissue samples for evaluation and chemical analysis. These investigative activities are consistent with EPA's current Statement of Work (SOW). The development and focus of the proposed sampling and analysis program, described herein, has been a cooperative effort among EPA, Louisiana Department of Environmental Quality (LDEQ), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), and CDM Federal.

This SAP conforms to the requirements of EPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), Interim Final, EPA/540/G-89/004 (EPA 1988). The Quality Assurance Project Plan (QAPP), Part II of the SAP, conforms to EPA's QA/R-5 QAPP preparation guidance (EPA 1998). The purpose of this SAP is to describe the sampling objectives, the proposed characterization tasks, project schedule, and quality assurance (QA) requirements for Phase II of the Calcasieu Estuary RI.

The SAP is organized as follows:

Section 1 - Introduction

Section 2 - Site Background

Section 3 - Phase II Sampling Strategy and Rationale

Section 4 - Field Activities, Methods, and Procedures

Section 5 - Project Management

Section 6 - Measurement and Data Acquisition

Section 7 - Assessment and Oversight

Section 8 - Data Validation and Usability

Section 9 - References

Appendix A - Health and Safety Plan

Appendix B - Standard Operating Procedures

Appendix C - Ecological Assessment and Measurement Endpoint Workshop

Appendix D - Specialized Sampling Equipment

Appendix E - Field Forms

Appendix F - Contract Laboratory Program Protocols

1.1 OBJECTIVES OF PHASE II SAMPLING AND ANALYSIS PLAN

The objectives described below are based on EPA's SOW, a review of existing hydrogeologic and geochemical data collected during previous studies, and the results of the Calcasieu Estuary Phase I RI. The specific Phase II objectives include:

1. Develop data quality objectives (DQOs) and sampling and analyses protocol that support characterization (nature and extent) of contamination within the estuary sediment and biota tissue. Established DQOs (Section 5.4) should result in data collection that enables a thorough assessment of human health and ecological risk and supports future FS data needs.

2. Minimize data gaps identified from the evaluation of the Phase I data by developing a sampling program to characterize the nature and extent of organic

and inorganic contamination in water and sediment within the selected sub-areas of the estuary.

3. Characterize the relationship between sediment chemistry and toxicity to support an evaluation of the ability of the Sediment Quality Guidelines (SQGs) to correctly classify sediments in the study area as toxic or not toxic.

4. Provide the information needed to evaluate the risks to sediment-dwelling organisms that are associated with exposure to contaminated sediments; and

5. Provide the information needed to evaluate the risk to fish and wildlife resources that are associated with consumption of contaminated prey items.

1.2 PROJECT SCHEDULE AND DELIVERABLES

This work assignment was initiated on May 18, 1999 with a scoping meeting at EPA Region 6 offices in Dallas, Texas. A site visit followed on May 21, 1999. Phase I sampling was conducted between November and March 2000. Phase II sampling is currently scheduled for November and December 2000 followed by data validation and evaluation and reporting. The period-of-performance of the work assignment is presently scheduled to end on June 30, 2002. Table 1-1 presents an abbreviated project schedule for the Calcasieu Estuary, including CDM Federal deliverables for the Calcasieu Estuary RI/FS through December 2001.

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2.0 SITE BACKGROUND

This section describes the site location, physiographic features, and environmental setting of the Calcasieu Estuary and possible reference sites. The reference sites, SNWR and Calcasieu Lake, will be used as a baseline for sediment toxicity testing. Portions of these discussions were obtained from the following:

- *Bayou d'Inde Expanded Site Inspection - Final Report* prepared by PRC Environmental . (PRC) for EPA (PRC 1993),
- *Site Investigation Report for Bayou Verdine,* prepared by PRC for EPA (PRC 1994),
- *Contamination Extent Report and Preliminary Injury Evaluation Report (Public Review Draft),* prepared by Industrial Economics, Inc. for NOAA (NOAA 1996),
- *Toxics Study of Lower Calcasieu River,* prepared by Research Triangle Institute (RTI) for EPA (RTI 1990),
- *Contamination Extent Report and Preliminary Injury Evaluation for the Calcasieu Estuary*, prepared by Industrial Economics, Inc. for NOAA (NOAA 1997),
- *Louisiana Coastal Wetlands Restoration Plan, Calcasieu/Sabine Basin, Appendix I,* prepared by the Louisiana Coastal Wetlands Conservation and Restoration Task Force, June 1993.

2.1 SITE LOCATION AND PHYSIOGRAPHIC FEATURES

The Calcasieu Estuary is located between the cities of Westlake and Mossville, and north-northwest of Lake Charles in Calcasieu Parish, Louisiana. Headwaters of the Calcasieu River, Bayou Verdine, and Bayou d'Inde originate in the farmland north of Mossville and flow primarily south-southeast entering the Calcasieu River on the north end of Coon Island Loop.

The Calcasieu River is the principal surface water conduit in the Calcasieu Estuary, Calcasieu

Parish, Louisiana. The Calcasieu River was dredged in 1941 to create the ship channel. The installation of the Ship Channel changed the rivers natural saltwater barriers' effectiveness and impacted marsh areas to the west of Calcasieu Lake. This impact on the river's natural saltwater barrier, has allowed saltwater to migrate upstream from the Gulf of Mexico, reducing the natural freshwater areas in the estuary.

The Ship Channel is routinely dredged and is maintained at a depth of approximately 45 feet. Water control structures were installed by the USFWS in an effort to reduce the saltwater impact of the Ship Channel. The most significant structure in the estuary is the hydraulic salt water barrier at the north end of the Upper Calcasieu AOC. Data monitoring points are currently maintained by the USFWS to evaluate the effectiveness of this and other central structures.

Various portions of the Estuary support recreational hunting and fishing. The Estuary contains several delineated wetlands. Health advisories warning of contaminated fish consumption have been in effect since 1987 for the Calcasieu Estuary (LDEQ 1999) Although the estuary is not used as a drinking water source, the surface waters have been designated by the Louisiana Department of Environmental Quality (LDEQ) as supporting primary contact recreation, secondary contact recreation, and fish and wild life propagation (PRC 1994). The Calcasieu Estuary has not been proposed for inclusion on the National Priorities List (NPL), but has been the subject of environmental studies dating back to the early 1970s.

The SNWR was established in 1937 and is the largest coastal refuge located on the Gulf of Mexico. It is located in southwest Louisiana in Cameron and Calcasieu Parishes and consists of 139,000 acres. Man-made controls have been added to protect the refuge. Breakwaters installed in the Gulf near Holly Beach by the State of Louisiana to protect the SNWR shoreline is one example of the many structures installed to protect the refuge. Where interior marshes were destroyed by canal-induced saltwater intrusion, wave-break levees were installed in open water areas to reduce wind/wave induced erosion of adjacent marsh shores. These actions have helped preserve the marshes in the refuge and have helped minimize further saltwater intrusion, however, during low precipitation conditions, as is the current status, salinities are generally higher. These conditions prevail in Calcasieu Lake and the Calcasieu Estuary, as well.

Calcasieu Lake is south of Moss Lake. The lake is a coastal lagoon system that is predominantly less than six feet deep. Originally, the Calcasieu River passed through the lake; however, when the ship channel was dug a spoil bank was constructed to separate the river/ship channel from the lake. Calcasieu Lake is still connected to the Calcasieu River and ship channel at its northern and southern ends, but river flow largely bypasses the lake.

2.1.1 BAYOU VERDINE

Bayou Verdine, described below, is a narrow bayou extending north west from Coon Island and is one AOC within the estuary. The investigation for all of Bayou Verdine will be conducted by Conoco Incorporated. However, CDM Federal performed limited Phase I RI sampling in Bayou Verdine that consisted of limited chemical analyses (ie.) (dioxin/furans, semi-volatile organic compounds (SVOCs) and metals) in the corner reaches and volatile organic compounds (VOCs), SVOCs, metals, herbicides, pesticide/polychlorinated biphenyls (PCBs), and dioxin/furans samples in the upper most reach of Bayou Verdine. The EPA will prepare a comprehensive RI for this AOC that will incorporate samples collected by EPA and Conoco. EPA provides technical review and oversight of the Conoco sampling plans and field work. All proposed Phase II sampling for Bayou Verdine to be conducted by Conoco has been reviewed and approved by EPA. The subject tasks are presented in the *Work Plan for the Baseline Ecological Risk Assessment (BERA) and Human Health Risk Assessment (HHRA) for the Bayou Verdine Study Area, Lake Charles, Louisiana*, prepared by ENTRIX, Inc. for Conoco, April 2000.

Bayou Verdine is located between the cities of Westlake and Mossville, and north-northwest of Lake Charles in Calcasieu Parish, Louisiana. Bayou Verdine's headwaters originate in the farmland north of Mossville and flow primarily south-southeast entering the Calcasieu River on the north end of Coon Island Loop. For purposes of the RI, Bayou Verdine is defined by the surface water and sediments within the bayou and immediately adjacent wetland areas which may have been impacted by industrial activity. Industrial properties adjacent to the bayou are not currently included in the Phase II investigation. Bayou Verdine is within Sections 27, 28, 33, and 34, Township 9 South, Range 9 West, and Section 3 of Township 10 South, Range 9 West. Bayou Verdine is approximately 4.2 miles long, and the bayou is the only major tributary to Calcasieu River-Coon Island Loop (NOAA 1997).

Additional background information is presented in the CDM Federal 1999 Phase I SAP. Bayou Verdine is a wetland bayou that flows through or adjacent to property owned by Vista Chemical Corporation (Vista), Conoco, Inc. Lake Charles Refinery (Conoco), and Pittsburgh Paint and Glass Industries, Inc. (PPG). These facilities are all active.

2.1.2 BAYOU D'INDE

Bayou d'Inde is located in the northern portion of the Calcasieu Estuary, west of the city of Lake Charles in Calcasieu Parish, Louisiana. Bayou d'Inde's headwaters originate in the western part of Sulphur, Louisiana and flow primarily east-southeast through heavy commercial and industrialized areas emptying into the Ship Channel west of Lake Charles. Bayou d'Inde is within Sections 11 and 12, Township 10 South, Range 10 West, and Sections 5, 6, 7, 8, 9, 10, and 16 of Township 10 South, Range 9 West. Bayou d'Inde is approximately 9 miles long and is a major tributary of the Calcasieu River (NOAA 1997).

Bayou d'Inde is a tidally influenced wetland bayou that flows through or adjacent to property owned by Citgo Petroleum Corporation (Citgo), OxyChem Corporation (OxyChem), Firestone Synthetic Rubber and Latex Company (Firestone), Westlake Polymers Corporation (Westlake Polymers), Browning-Ferris Industries (BFI), Certain-Teed Products Corporation (Certain-Teed), and PPG. These facilities are all active.

The land around Bayou d'Inde includes undeveloped wooded marsh land, rural residential, commercial, and heavy industrial property. Rural residential and undeveloped woodland areas border the bayou northwest and upgradient of the industrial area. Heavy industry dominates the middle and southern reaches of Bayou d'Inde on both sides. Several of these industries have wastewater outfalls permitted under NPDES. Permitted industrial discharges to Bayou d'Inde include outfalls belonging to Citgo, OxyChem, Firestone, Westlake Polymers, BFI, Certain-Teed, and PPG. In addition, PPG discharges wastewater to Bayou d'Inde via the PPG Canal, which enters the bayou approximately one mile upstream of the Calcasieu Ship Channel. These discharges (current and historic), stormwater runoff, and accidental releases have contributed to organic and inorganic impacts to surface water, sediment, and biota within the Bayou d'Inde.

Although Bayou d'Inde is not used as a drinking water source, the estuary surface waters have been designated by LDEQ as supporting primary contact recreation, secondary contact recreation, and fish and wildlife propagation (PRC 1993). Bayou d'Inde supports recreational fishing and has several delineated wetlands that are considered sensitive environments. Health advisories warning of contaminated fish consumption have been issued for the Calcasieu Estuary, including Bayou d'Inde (LDEQ 1999).

2.1.3 UPPER CALCASIEU

Upper Calcasieu extends from the saltwater barrier of the Calcasieu River to approximately 500 feet south of Coon Island, and includes Lake Charles, Clooney Island Loop, and Coon Island Loop. From the saltwater barrier, the Calcasieu River flows sinuously to the southwest into Lake Charles, then west to Clooney Island Loop, and then southwest to Coon Island Loop. Surface water flow from Coon Island Loop connects with the ship channel surface water at the southern end of Coon Island.

Upper Calcasieu is within Sections 26, 35, and 36 of Township 9 South, Range 9 West, and Sections 1, 2, 3, 10 and 11 of Township 10 South, Range 9 West. Land use within the Upper

Calcasieu (i.e., Lake Charles area) consists of residential, commercial, and industrial use. Clooney Island and Coon Island Loops are characterized by industrial development. The islands within the loops are dredge spoils and portions of Coon Island are intermittently submerged.

For purposes of the RI, Upper Calcasieu is defined by the surface water and sediments within the banks of the Calcasieu River and Ship Channel, including Lake Charles, Clooney Island Loop, Coon Island Loop, and adjacent wetland areas that may have been impacted by industrial activities. The Upper Calcasieu River and Ship Channel is tidally-influenced with salinity stratification promoted by the interaction of salt water from the Gulf of Mexico (to the south) moving northward and fresh water moving south.

Upper Calcasieu is approximately 15 miles in length and receives discharges from several sources along its banks. Bayou Verdine and Bayou Contraband are the two major tributaries in that discharge into the Calcasieu River and Ship Channel. Bayou Verdine which passes through several industrial properties discharges at the northern edge of Coon Island Loop. Bayou Contraband discharges near the port of Lake Charles between Clooney and Coon Island Loops and is receiving waters for Lake Charles municipal waste water (NOAA 1997). Industries that have waste water outfalls permitted under NPDES include PPG and Olin. In addition, Conoco operates a dock area at the north end of Clooney Island Loop. These facilities are all active. Discharges (current and historic), stormwater runoff, and accidental releases have contributed to organic and inorganic impacts to surface water, sediment, and biota the Upper Calcasieu.

Although the Calcasieu River is not used as a drinking water source, the estuary surface waters have been designated by LDEQ as supporting primary contact recreation, secondary contact recreation, and fish and wildlife propagation (PRC 1993). The Calcasieu River also supports recreational and commercial fishing and has several delineated wetlands that are considered sensitive environments. Health advisories warning of contaminated fish consumption have been issued for the Calcasieu Estuary, including the bayous (LDEQ 1999).

2.1.4 LOWER CALCASIEU

Lower Calcasieu extends from Coon Island Loop to Moss Lake is located within Sections 15, 16, 17, 19, 20, 21, 22, 28, 29, 30, 31 and 32 of Township 10 South Range 9 West, Sections 1, 2, 11, and 12 of Township 11 South Range 10 West, and Sections 6 and 7 of Township 11 South Range 9 West. Beyond Coon Island Loop, the ship channel flows southwest, partially isolating Prien Lake (on the northeast). The northern part of Prien Lake receives inflow from the ship channel, and the lake's outflow discharges back into the ship channel downstream of the mouth of Bayou d'Inde. There is also a connection between the ship channel and Prien Lake across from the mouth of Bayou d'Inde. After the confluence of the Prien Lake portion of the original river and the Calcasieu Ship Channel, the Calcasieu River flows south along the eastern edge of Moss Lake toward Calcasieu Lake and the Gulf of Mexico.

For the purpose of the RI, Lower Calcasieu is defined by the surface water and sediments within the banks of the Calcasieu River and Ship Channel, Moss lake, and adjacent wetland areas that may have been impacted by industrial activities. Much of the land in this area of the river is undeveloped marshland, but the industrial facilities, Himont, Citgo, and W.R.Grace, all have outfalls to the river between Prien Lake and Moss Lake. Bayou Olsen that flows into Moss Lake is a small tributary to the Calcasieu River and Ship Channel in the Lower Calcasieu.

2.1.5 SABINE NATIONAL WILDLIFE REFUGE

The Sabine National Wildlife Refuge (SNWR) contains over 139,000 acres and consists of a wide range of habitat. Three freshwater impoundments as well as numerous ridges, bayous, man-made canals and levees, ponds, lakes, and wooded islands are some of the various features found in this marsh. The approximate northern boundary of the basin is Interstate Highway 10; the eastern boundary follows the eastern leg of State Highway 27; the western boundary is the Sabine River and Sabine Lake; the southern boundary is the Gulf of Mexico.

Most of SNWR was previously owned by Orange-Cameron Land Company, which used the marsh for trapping and hunting. The company constructed many of the canals and levees that still exist and operated a major fur-pelt processing facility. The depopulation of muskrats eventually ruined the fur business, and the property was sold to the federal government for the establishment of the refuge.

Intrusion of salt water into former fresh- and brackish-water marshes is a common problem in the region. Only three of the nine refuge impoundments are fresh-water marshes. The increase in salinities is due in part to the construction of the Intracoastal Waterway, a 2500-mile ship channel between Brownsville, Texas, and Trenton, New Jersey, constructed in the 1940s. The Intracoastal Waterway is on average, 49-foot deep, north of the refuge. It has intercepted fresh-water drainage from the north, it provides an inlet for saltwater to reach the inland marshes. Whereas normal salinities in the refuge are 2 parts per thousand (ppt) or less, salt-water intrusion and low precipitation can increase salinities to 22.5 ppt.

The Soil Conservation Service has developed an area-wide plan to control or reduce salt water intrusion. With 61 miles of levees and eight major water-control structures, refuge personnel manipulate water levels to maintain and safeguard the wildlife habitat.

2.1.6 CALCASIEU LAKE

Calcasieu Lake is approximately 4 miles located downstream of Moss Lake. The lake is a coastal lagoon system that is predominantly less than six feet deep. Originally, the Calcasieu River passed through the lake; however, when the ship channel was dug a spoil bank was constructed to separate the river/ship channel from the lake. Calcasieu Lake is still connected to the Calcasieu River and Ship Channel at its northern and southern ends, but river flow largely bypasses the lake.

2.2 PREVIOUS INVESTIGATIONS

The Phase I RI and other pre-RI investigations indicate that surface water and sediment in the Calcasieu Estuary have been impaired by (VOCs), (SVOCs), (PCBs), pesticides, total petroleum hydrocarbons (TPHs), and various inorganic elements (e.g., heavy metals). Section 2.2.1 provides a brief overview of the Phase I sampling program. Section 2.2.2 lists the investigations performed prior to the current RI/FS effort and provides a brief summary of the results of each. Section 2.2.3 describes the environmental setting of the area.

2.2.1 PHASE I RI OVERVIEW

The Phase I sampling and analysis was conducted from December 1999 through March 2000 by CDM Federal. The objective of Phase I was to determine the nature and extent of contamination in the Calcasieu Estuary in support of human health and ecological assessment and feasibility study data needs. Based on geographic, hydrologic, and discharge characteristics, the location of industry on the estuary, and historical data, the estuary was divided into four areas of concern (AOC); Bayou Verdine, Bayou d'Inde, Upper Calcasieu, and Lower Calcasieu. Each AOC was then subdivided into reaches, using the same rational. Approximately 1500 sediment and surface water samples were collected from over 600 locations throughout these AOCs. Information pertaining to the Phase I design strategy, sample locations, and analysis can be found in the following documents:

- *Phase I Sampling and Analysis Plan For Remedial Investigation/Feasibility Study of Bayou Verdine Area Of Concern, Calcasieu Estuary Cooperative Site, Lake Charles, Louisiana, October 1999.* CDM Federal.

- *Phase I Sampling and Analysis Plan For Remedial Investigation/Feasibility Study of Bayou d'Inde Area Of Concern, Calcasieu Estuary Cooperative Site, Lake Charles, Louisiana, November 1999.* (CDM Federal 1999).

- *Phase I Sampling and Analysis Plan For Remedial Investigation/Feasibility Study of Upper Calcasieu Area Of Concern, Calcasieu Estuary Cooperative Site, Lake*

Charles, Louisiana, December 1999. (CDM Federal 1999).

- *Phase I Sampling and Analysis Plan For Remedial Investigation/Feasibility Study of Lower Calcasieu Area Of Concern, Calcasieu Estuary Cooperative Site, Lake Charles, Louisiana, November 1999.* (CDM Federal 1999).

Several potentially responsible parties (PRP) voluntarily participated in the Phase I characterization efforts. These PRPs include Conoco who performed the sampling of Bayou Verdine and Olin Chemical who performed sampling of Coon Island Loop. In addition Citgo and PPG split samples within their respective areas of interest. All of these PRP data have been submitted to EPA for review and inclusion in the site-wide database.

Preliminary data evaluation indicated exceedences of sediment Effects Range-Median value, (ERMs; Long et al. 1995) for metals, SVOCs, PCBs, and dioxin/furans along with exceedences of Ambient Water Quality Criteria (AWQC; Fed Reg 60: 22229-22237, Fed Reg 63: 68353-68364) for metals at various locations throughout the estuary. Section 3 of this document will describe the objectives, design, and sampling strategy of the Phase II RI.

2.2.2 PRIOR INVESTIGATIONS

The following documents describe investigations within the Calcasieu Estuary prior to the current RI/FS.

Toxics Study of the Lower Calcasieu River, Research Triangle Institute, March 1990.

> The Toxics Study of the Lower Calcasieu River summarizes the results of a toxics study conducted by EPA Region 6, the LDEQ, and the U.S. Geological Survey (USGS). The study area included the Lower Calcasieu River, Bayou d'Inde, Bayou Verdine, Prien Lake, Lake Charles, Moss Lake, and Calcasieu Lake. Water and sediment samples were collected in June and July of 1988 and April 1989. Water samples were mid-channel, mid-depth grab samples. Sediment samples were composite samples consisting of three grab samples (river locations). Grab samples were also taken from waste water effluent from industrial facilities.

Samples were tested for VOCs, SVOCs, PCBs, pesticides, inorganic elements, anions, and conventional chemical and physical parameters. Toxicity testing of effluent, water, and sediment samples was performed using six different bioassay species and methods. The report concluded that a variety of organic and inorganic constituents exist in the various media, which resulted in high mortality rates within the estuary.

Bayou d'Inde Expanded Site Inspection - Final Report. PRC Environmental Management, Inc., September 28, 1993.

The Bayou d'Inde Expanded Site Inspection was prepared for EPA as part of the CERCLA Hazard Ranking System screening process. The objectives of this study were to document contamination in Bayou d'Inde and to build on previously collected data by further defining site waste characteristics, contaminant sources, and exposure pathways. PRC Environmental collected samples from November 30 through December 4, 1992. Sediment samples were collected from near-shore and deeper channel locations.

Samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and inorganic elements. Sediment used for the VOC analyses was taken as a grab from a discrete sample interval; the remaining sample interval was homogenized for the SVOC, PCB, pesticide, and inorganic analysis. Numerous inorganic and organic contaminants were documented in Bayou d'Inde specifically concentrated from the industrial areas to its confluence with the Calcasieu River. Similar contaminants were also documented in the PPG Canal.

Bayou d'Inde, Lower PPG Canal, and Sediment Sampling Report. McLaren/Hart Environmental Engineering, ChemRisk Division, June 30, 1995.

The ChemRisk Sediment Sampling Report was prepared for PPG Industries, Inc. The objective of the study was to assess sediment and water quality in Bayou d'Inde, the Lower PPG Canal, and a portion of the Calcasieu Ship Channel. Surface water sample locations that exhibited salinity stratification were sampled three feet above the sediment and in the middle of the fresh water layer. At non-stratified sample locations, one surface water sample was collected at two-thirds the depth of the water. Five-foot-long sediment cores were collected from the main channel of Bayou d'Inde, and 10-foot cores were collected from the shallow sample locations within the bayou.

Water and sediment samples were tested for VOCs, SVOCs, PCBs, chlorinated pesticides, TPHs (i.e., gasoline and diesel), total and dissolved inorganic elements, ammonia, major anions, and conventional chemical and physical parameters. Conclusions state that, although many constituents were detected in surface water, there were no organic or inorganic contaminants that warranted additional characterization. However, for sediment, most organic and inorganic constituents were detected and warrant additional characterization because the extent of the constituents were not adequately characterized.

Focused Site Investigation, Bayou d'Inde U.S. EPA, July 1996.

The Bayou d'Inde Focused Site Investigation was conducted by Fluor Daniel, Inc. for the EPA Region 6 as part of the CERCLA site investigation process. The sampling was initiated in response to a proposed dredging permit within the lower 1,000 feet of Bayou d'Inde. The purpose of the study was to determine the areal extent of contamination within lower Bayou d'Inde. Water samples were collected from locations established at the confluence of Bayou d'Inde and the Calcasieu River and at 500, 1,000, and 5,000 feet upstream and downstream. Samples were collected from the surface and at near-bottom depth. Sediment core samples were collected from the lower 1,250 feet of Bayou d'Inde to depths of 10 to 20 feet.

All samples were analyzed for VOCs, SVOCs, inorganic elements, PCBs, and pesticides. Five sediment samples were also analyzed for dioxin. The findings suggest contaminated sediment to a maximum depth of 16.5 feet, however, the majority of the contaminants occurred in the upper four feet. Elevated concentrations of three dioxin were reported. In addition, approximately 65,000 cubic yards of contaminated sediment reportedly exists in an area proposed for dredging.

Louisiana Department of Environmental Quality, Calcasieu Estuary Water Sampling Program. 1987-1996.

LDEQ has measured ambient water conditions in the Calcasieu Estuary on a monthly basis since 1987. LDEQ collects water samples from seventeen discrete sampling locations within the estuary. Stations range from the saltwater barrier near Lake Charles to the southern end of Calcasieu Lake, and include Bayou d'Inde, Prien Lake, and portions of the Calcasieu River and Ship Channel. Over the history of the program, LDEQ has collected more than 2,000 water samples. These samples were analyzed for VOCs and conventional parameters such as dissolved oxygen and salinity. LDEQ did not analyze the data for SVOCs, PCBs, or inorganic elements.

Site Inspection for Bayou Verdine. PRC Environmental Management, Inc. May 1994.

The Site Inspection for Bayou Verdine was focused on areas of elevated contaminant concentrations. Background information presented in this report was prepared from a comprehensive file review. The study objective was to document the presence of hazardous substances in surface water and sediments from PPG's North Dock, a section of Coon Island Loop, and Bayou Verdine (including Kansas City Southern Railroad West Ditch, the Vista West Ditch, and the Faubacher Ditch). A total of 27 sediment and 23 surface water samples were collected from 27 stations within the study area from July 19 through July 22, 1993. Sediment samples were collected from near-shore and center channel areas with dedicated aluminum push tubes.

Sediment samples were analyzed for VOCs, SVOCs, PCBs, pesticides, and inorganic elements. Sediment for the VOC analysis were discrete depth grab samples; the remaining sample interval was homogenized for the SVOC, PCB, pesticide, and inorganic elemental analyses. Surface water samples were collocated with the sediment samples; however, they were only analyzed for VOCs. The primary contaminants of potential concern (COPCs) identified were benzo(a)pyrene, dibenz(a,h)anthracene, 1,2-dichloroethane, 1,1,2-trichloroethane, vinyl chloride, benzene, chromium, lead, and mercury.

Results of Preliminary Sediment and Surface Water Sampling and Analysis in Bayou Verdine and Coon Island Loop of the Calcasieu River. McLaren/Hart Environmental Engineering, ChemRisk Division. 1994.

The study objective was to characterize the nature and extent of chemical contamination in Coon Island Loop (including the PPG North Dock facilities) and a section of Bayou Verdine (from Interstate Highway 10 to the Coon Island Loop) for PPG. ChemRisk established 58 sampling stations within the study area. Twelve stations were located in Bayou Verdine; 16 were located in the PPG dock area and turning basin (including two transects); 18 stations (comprising six transects) were located in the west arm of Coon Island Loop; and 12 stations (including five transects) were located in the east arm and south end of Coon Island Loop.

ChemRisk collected 33 surface water samples from 25 stations from October 1 to October 15, 1993. Bayou Verdine, the dock area and turning basin, and the east and southern Coon Island Loop locations (17 stations) were sampled at one depth, at approximately two-thirds the depth of the surface water. Coon Island Loop locations from the western arm (eight stations) were collected from the center of the dredged ship channel at two depths. All samples were collected with a Van Dorn water sampler.

ChemRisk completed multi-depth (4 inches to 9 feet) sediment borings at the 58 different locations, from which 141 sediment samples were collected. Sediment samples from Bayou Verdine reached a maximum depth of two feet. Samples were collected using a vibratory corer and a two-inch, split barrel, PVC sampler.

All surface water and sediment samples were analyzed for VOCs, SVOCs, TPHs (i.e., diesel and gasoline fractions), PCBs, chlorinated pesticides, inorganic elements, anions, ammonia, and conventional physical and chemical parameters. A grain size analysis also was performed on the sediment samples. Analytical results showed elevated concentrations of organic and inorganic contaminants in the areas sampled.

Bayou Verdine Inspection, Lake Charles, Louisiana. Conoco. 1999.

Conoco conducted a field investigation that included shallow and deep sediment and surface water sampling program and a biological inventory evaluation on Bayou Verdine. The objective of the sampling effort was to characterize the nature of chemical constituents in Bayou Verdine as well as delineate the extent of those constituents. The objective of the biological inventory was to identify representative plant and wildlife species inhabiting the area. Environmental sampling and the biological inventory were completed during 1999. Analytical protocols included VOCs, SVOCs, pesticides, PCBs, and inorganic elements in addition to numerous physical parameters. The results of the investigation have been reviewed by EPA and were used by Conoco to generate a Phase II SAP for Bayou Verdine. None of the Bayou Verdine plans or results will be included in the overall Calcasieu Estuary RI/FS, Conoco, Inc. will report those directly to EPA.

2.3 ENVIRONMENTAL SETTING

The environmental setting includes a discussion of the local geology and soils (Section 2.3.1); the regional hydrogeology (Section 2.3.2); hydrology of the Calcasieu Estuary (Section 2.3.3) including Upper Calcasieu, Bayou d'Inde, Lower Calcasieu, and the reference site SNWR; and local climate (Section 2.3.4).

2.3.1 GEOLOGY AND SOILS

The Calcasieu Estuary Site is located within the Gulf Coastal Plain physiographic province of southwestern Louisiana. The area is comprised primarily of geologically young unconsolidated Quaternary (Pleistocene-age) sediments. Structurally, the area consists of a geosyncline that has been and is still receiving large quantities of sediment from multiple river discharges (Louisiana Geological Survey [LGS] 1984).

Quaternary sediments are Pleistocene-age terraces deposited on the Gulf Costal Plain during glacial retreats (PRC 1994). These sediments are typically composed of interbedded sands, gravels, silts, and clays. Four terrace deposits have been identified in Calcasieu Parish: the

Williana, Bentley, Montgomery, and Prairie. The Bentley, Montgomery, and Prairie are exposed at the surface in the Calcasieu Parish. The surficial deposits in the Lake Charles area are clays, silts, fine sand, and shells of the Prairie Terrace (LGS 1984).

These Pleistocene terrace formation deposits include the “200-,” “500-,” and “700-foot” sands, that comprise the Chicot aquifer that underlies the site. These units generally thicken with depth toward the south. Faulting associated with the local Lockport and Sulphur Mines piercement salt domes may have caused the local variations in thickness and dip.

In some locations, the Pleistocene terrace deposits may be overlain by Holocene alluvium consisting of sandy and gravelly channel deposits mantled by sandy to muddy natural levee deposits, with organic-rich muddy backswamp deposits in between them (LGS 1999). The local soils consist of Basile and Guyton silt loams. These soils are frequently flooded, very low to low permeability, poorly-drained silt loams (PRC 1994). Site investigations within the Estuary describe the surficial sediments as silt with varying amounts of sand, clay and organic matter. The silt is typically black, with plant and shell fragments.

2.3.2 HYDROGEOLOGY

Significant groundwater aquifers exist below the site. Within the upper 1000 feet of Quaternary sediments, the local aquifers include a shallow unconfined aquifer and the deeper confined, Chicot aquifer. These aquifers typically consist of sand and gravel units separated by clay aquitards (PRC 1994).

There has been relatively little study of the shallow aquifer. The following description of this aquifer is based on conversations with EPA Region VI and LDEQ technical staff familiar with the area, as well as published data. The shallow aquifer is comprised of unconsolidated sand units referred to as the “10-”, “20-”, and “36-foot” sands in the vicinity of PPG (PRC 1994). Groundwater in this aquifer is unconfined and occurs at depths of less than 1 foot to 3 feet below ground surface (bgs). Groundwater flow, fluctuation, and quality may be influenced by surface water that intercept the shallow groundwater (PRC 1994). In addition, water levels in the shallow aquifer are tidally influenced with up to several inches of daily fluctuation. Because of the local influences, groundwater flow directions are irregular and vary seasonally. The water quality is typically poor and unsuitable for domestic use. There are no known wells completed in the shallow aquifer in the vicinity of the study area.

Recharge to the shallow aquifer is from infiltration of precipitation, impoundments, and surface water. Groundwater may also discharge to surface water in some locations (PRC 1994). Further information on the deeper regional aquifers are discussed in the Phase I SAPs (CDM Federal 1999 a, b, c, d).

2.3.3 HYDROLOGY OF THE CALCASIEU ESTUARY

2.3.3.1 Bayou Verdine

As noted previously, all work in Bayou Verdine will be performed by Conoco, Inc., Phase II efforts are provided in the *Work Plan for the Baseline Ecological Risk Assessment (BERA) and Human Health Risk Assessment (HHRA) for the Bayou Verdine Study Area, Lake Charles, Louisiana*, prepared by ENTRIX, Inc. for Conoco Inc., April 2000. An overview of Bayou Verdine is provided below to complete the description of the Estuary.

Bayou Verdine is approximately four miles long. Relief in the area of the bayou ranges from 5 to 15 feet above national geodetic vertical datum (NGVD). The area surrounding Bayou Verdine is located within the 100-year flood plain of the Calcasieu River Basin (PRC 1994). Its headwaters are freshwater that mix with brackish to saline water of the Calcasieu River to the south.

According to the USFWS National Wetland Inventory Map, the upper reaches of Bayou Verdine (from point of origin to Interstate 10 [I-10]) are comprised of a palustrine wetland system that is periodically flooded during storm events, and a riverine segment that is permanently flooded. The upper reaches of the bayou have water depths ranging from 1.2 to 2.1 meters (m) [approx 4-7 feet], and are not tidally influenced. The lower segment of the bayou is tidally influenced with up to three inches of daily water level fluctuation, and has depths of up to 6 m (20 feet). The bayou has an estimated average rate of flow of approximately eight cubic feet per second (cfs) in its southern reaches. Near the confluence of Bayou Verdine and the Coon Island Loop, Bayou Verdine and the shallow groundwater are in direct communication (PRC 1994).

2.3.3.2 Bayou d'Inde

Bayou d'Inde's headwaters originate in the western part of Sulphur, Louisiana and flow primarily east/southeast through heavy commercial and industrialized areas emptying into the Calcasieu ship channel west of Lake Charles. Bayou d'Inde is approximately 9 miles long and is a major tributary of the Calcasieu River (NOAA 1997). The bayou originates near the I-10 bridge with a drainage area of over 1000 acres (PRC 1993).

Bayou d'Inde is a tidally influenced wetland bayou. The surface elevation in the area of the bayou averages about 10 feet above mean sea level (msl). The area surrounding Bayou d'Inde is located within the 100-year flood plain of the Calcasieu River Basin (PRC 1994). The Bayou ranges from 80 to 150 feet wide and up to 16 feet deep. Depth is greatest in Reaches 1 and 3 where the Bayou is routinely dredged. Reach 2 is a low lying, flooded area with water depth generally less than 3 feet.

Flood water frequently covers the soils surrounding the bayou to depths of 1 to 6 feet for periods of up to 10 days, mostly in winter and spring (PRC 1993). Bayou d'Inde headwaters are typically fresh in Reach 5 mixing with brackish to saline water of the Calcasieu River to south (Reaches 1-4). Salinity can vary significantly and is dependant upon rainfall, water levels within the Estuary system, and other conditions.

According to the USFWS National Wetland Inventory Map, the upper reach of Bayou d'Inde (from point of origin to approximately 0.25 miles south of Elliswood Drive bridge (Reach 5) is comprised of a riverine segment that is permanently flooded. This portion of the bayou has water depths ranging from 1.2 to 2.1 meters (m) (approximately 4 to 7 feet), and is not tidally influenced. Reach 4 of the bayou has water depths ranging from 2 to 4 m (approximately 7 to 12 feet), and is presumed not to be tidally influenced. The lower segments of the bayou (Reaches 1 through 3) are tidally influenced with up to three inches of daily water fluctuation and have channel depths of up to 5 m (16 feet).

2.3.3.3 Upper Calcasieu

Upper Calcasieu is approximately 15 miles in length and receives discharges from several sources along its banks. Bayou Verdine and Bayou Contraband are the two major tributaries that discharge into the Calcasieu River and Ship Channel. Bayou Verdine passes through several industrial properties and discharges at the northern edge of Coon Island Loop. Bayou Contraband passes through mostly residential and light industrial properties and discharges near the port of Lake Charles. Bayou Contraband is also the receiving water for Lake Charles municipal waste water (NOAA 1997).

Upper Calcasieu is approximately 15 miles long from the saltwater barrier to just south of Coon Island loop and includes Lake Charles and Clooney and Coon Island Loops, with a drainage area of over 1,000 acres (PRC 1993). The surface elevation in the area around Upper Calcasieu averages about 10 feet above mean sea lever (msl). The area is located within the 100-year flood plain of the Calcasieu River Basin (PRC 1994). Upper Calcasieu ranges from 200 to 1200 feet wide in the river channel to as much as 6000 feet wide in the Lake Charles segment. Water in the Upper Calcasieu is brackish, and tidally influenced. The river channel depth ranges from 15 to 45 feet in depth; however, deeper portions of the ship channel are excluded from this investigation because of routine dredging.

2.3.3.4 Lower Calcasieu

The Calcasieu River is the principal conduit in the Calcasieu Estuary, Calcasieu Parish, Louisiana. Lower Calcasieu River is approximately five miles long with a relief range from 5 to 15 feet above national geodetic vertical datum (NGVD). The area surrounding Lower Calcasieu is located within the 100-year flood plain of the Calcasieu River Basin (PRC 1994).

Its headwaters are brackish to saline as is the Calcasieu River and Upper Calcasieu to the north. Lower Calcasieu receives water from Bayou d'Inde, Bayou Olson, as well as unnamed drainages. It is tidally influenced with daily fluctuations of up to 3 inches, throughout and becomes more saline to the south.

2.3.3.5 Hydrology of Reference Sites, Sabine National Wildlife Refuge and Calcasieu Lake

The installation of the Gulf Intracoastal Waterway (GIWW) and the Calcasieu ship channel altered the natural saltwater barriers and impacted marsh areas north of Calcasieu Lake, namely the SNWR. The vast interior freshwater marshes south of the GIWW deteriorated to three fresh marsh impoundments and a few small remnants. Because of this marsh deterioration and loss through the 1960s and 1970s, large areas of turbid shallow open water and broken marsh resulted. SNWR marshes adjacent to large open water areas such as Black Lake, Brown's Lake and others experience erosion due to wave action. Wind actions across these areas produce wind tides that may exacerbate the export of eroded soils.

Historically, SNWR marshes drained to natural bayous that carried the excess water to the Calcasieu and Sabine Lakes. Increased channelization reduced the freshwater retention of interior marshes by connecting these bayous with man-made canals. Drainage capacity and discharge rates increased from the marshes to the lakes. Controlled water releases at Toledo Bend Dam and Sam Rayburn Dam also altered flows through SNWR into Calcasieu and Sabine Lakes.

A number of structural measures installed address some problems associated with channelization. Most of these measures are located along the Calcasieu lakeshore to protect marshes in and around the SNWR wildlife areas. Water control structures and perimeter levees are maintained to reduce saltwater intrusion and water level fluctuations.

Low-salinity marshes located within the east and northeast portion of the Cameron-Creole Watershed and midway between Sabine and Calcasieu Lakes, i.e., SNWR support both freshwater and estuarine-dependent fish and shellfish. Water control structures may reduce the numbers of juvenile estuarine fish and shellfish in the restored areas, however, the degree of impact is minimized by timing frequency and duration of structure closures.

2.3.4 CLIMATE

The climate in Calcasieu Parish is humid and temperate, and is influenced by its proximity to the Gulf of Mexico. The average year-round temperature is 68 degrees Fahrenheit (^{B}F), with an average daily high of 78 ^{B}F and an average daily low of 58 ^{B}F. The hottest months are July and August with average high and low temperatures of 91^{B}F and 73 ^{B}F, respectively. The average high and low temperatures for the coolest months, January and February are 63 ^{B}F and 41 ^{B}F, respectively.

Precipitation is relatively uniform from year to year. The average annual precipitation is 54.05 inches, with an average number of 103 rainy days (National Weather Service [NWS] Southern Region Climate Center 1999). May, June, and July typically experience the most precipitation, whereas March and October are the driest months. The average wind speed is 8.6 miles per hour, from the south.

Hurricane season officially runs from June 1st to November 30th. The Gulf Coast is vulnerable to hurricanes because of its proximity to tropical waters and because the warm water of the Atlantic Ocean and the Gulf of Mexico are attractive to storm growth. The last hurricane to actually traverse Lake Charles was hurricane Audrey in 1957. From 1886 through 1997, 71 tropical storms of which 34 were hurricanes, came within 150 nautical miles of Lake Charles (NWS 1998). Typical storm impacts for the Calcasieu Estuary and SNWR include tornadoes, floods, and storm surges that can raise the water level to several feet above normal.

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3.0 PHASE II SAMPLING STRATEGY AND RATIONALE

The Field Sampling Plan (FSP) includes Sections 3.0 and 4.0. This section describes the sampling strategy for completing Phase I data gaps (Section 3.1), conducting the sediment triad investigation (Section 3.2), collecting fish and invertebrate tissue (Section 3.3), and sampling confined disposal facilities (Section 3.4) for the Calcasieu Estuary and the two reference areas SNWR and Calcasieu Lake.

3.1 PHASE I DATA GAPS

This section addresses the collection of sediment samples to (1) complete data gaps, (2) delineate impacted areas, (3) determine PCB congeners and concentrations, and (4) determine contaminant levels for locations selected for the sediment triad investigation. Sediment samples from Phase I and II will be used to determine contaminant gradients and for risk assessment evaluations. Sample data will also support the RI nature and extent characterization, FS, and evaluation of potential future remedial actions. Most sediment samples will be surface grab samples (i.e., 0 to 10 cm [4-in.] depth) and will be collected in Bayou d'Inde, Upper and Lower Calcasieu, and the two reference sites, SNWR and Calcasieu Lake. A selected number of locations will have samples collected from depth intervals of 10 to 20-cm (4 to 8-in.) and 20 to 30-cm (8 to 12-in.) and are addressed in Section 3.1.1.2.

3.1.1 DESIGN STRATEGY

Based upon the RI Phase I data, a July 25, 2000 meeting identified the chemicals of potential concern (COPCs) in the Calcasieu Estuary. The COPCs that were identified were polycyclic aromatic hydrocarbons, copper, mercury, 1,2-dichloroethane, chromium, lead, nickel, zinc, aldrin, dieldrin, polychlorinated biphenyls (PCBs), bis(2-ethylhexyl) phthalate and dioxin/furans. COPCs found in surface water are the contaminants that occurred in unfiltered water samples at concentrations in excess of final chronic value of the EPA Ambient Water Quality Criteria

(AWQC). COPCs found in the sediment constitutes substances that occurred in whole sediments at concentrations in excess of the ERMs or comparable sediment quality screening level (i.e., probable effect levels; MacDonald *et al.* 1996; CCME 1999). Areas where concentrations of one or more sediment-associated substances exceeded the ERM or a comparable screening level were considered to be sub-areas with the Phase I AOCs. These sub-areas are identified in Section 1.

Samples collected to minimize data gaps will address high detection limits, extent of contamination, PCB congeners, as well as support removal possibilities.   Soil density and Eh parameters will be collected at every sample location. This data will be used by the engineers in development of the FS. In addition, the soil density provides physical characteristics of the sediment that is useful in describing sub-area habitat.

Professional judgement was used to determine the sampling locations. These locations were based on the concentration of contaminant from the Phase I investigation and additional needs for that location (e.g., lower detection limit for SVOCs, PCB congener analysis).

3.1.1.1 High Detection Limits

Some data from the Phase I investigation was suspect due to high detection limits or laboratory reporting limits that were above screening levels. Phase II investigation samples will be collected at locations within the designated sub-areas where high detection or reporting limits in some samples prevented a complete understanding of the distribution of contaminants in the estuary. High detection limits resulted from elevated moisture content or other matrix effects in the sediment samples analyzed for SVOCs. EPA and CDM Federal researched this issue with several analytical laboratories. A modification in the analytical method by the Contract Laboratory Program (CLP) should provide better resolution and lower detection limits to compensate for the high moisture content during Phase II.

The Phase II investigation samples will be collected in locations where detection limits were greater than sediment screening levels. Samples will be collected only in the delineated sub-areas.

3.1.1.2 Extent of Contamination

To further define the extent of contamination, sediment samples will be collected either horizontally or vertically from selected sample locations. Most locations are controlled horizontally by physical features of the estuary such as the shoreline. Horizontal delineation sample locations were chosen based upon biased spatial definition within a sub-area and controls surrounding a location or areas that had COPCs above screening levels. Vertical profile samples will be collected to determine if sedimentation has covered contaminants as well as determining if they pose a risk to the environment or will be exposed during remediation or other processes (i.e. storms). Delineation of COPCs will aid in the determination of possible sources of contamination and quantity of sediment impacted in support of future remedial actions.

3.1.1.3 PCB Congeners

These samples will be collected in locations where PCBs were detected in the Phase I samples. Affected sediment samples will be collected to characterize PCB congeners in the sub-areas. The PCB congeners that will be analyzed in the Phase II investigation are located in Table 3-1 (Valoppi, L. *et al.*, 1999). This list of PCB congeners is based on the World Health Organization list (WHO; Ahlborg *et al.*, 1994) and/or National Institute of Standards and Technology list (NIST; NOAA, 1993). The list includes 61 congeners comprised of the 12 congeners with dioxin-like activity (Van den Berg *et al.*, 1998), 20 congeners selected by NOAA for the National Status and Trends Program (NS&T; NOAA 1993), 22 congeners recommended by MacDonald (MacDonald *et al*., 1999) and 23 congeners recommended by Fairey (Fairey *et al*., 1996). The congeners proposed by NOAA are included on their toxicity and ubiquitousness in

the marine environment, or because they are being quantified by other scientific organizations

(NOAA 1993).

3.1.1.4 Assessment of Removal Possibilities

Sediment samples will be collected for toxicity characterization leaching procedure (TCLP) metals and SVOC analyses. The sample data will be used to support the FS. Samples will be collected in lower Bayou d'Inde, Olin Slip, and in the Citgo surge pond.

3.1.1.5 Surface Water Quality

Surface water quality samples will be collected at each of the sediment triad locations (Section 3.2) to characterize the overlying water above sediment samples. These data will support surface water characterization. Limited chemical data will be collected at select locations to determine nature and extent of contaminants and support risk assessment evaluations.

Physical, water quality parameters will be collected at all surface water locations [e.g. temperature, pH, conductivity, salinity, oxidation/reduction potential (ORP), dissolved oxygen, and turbidity]. These parameters will be measured at the surface then in two-foot increments through the entire water column. Salinity values will be used to determine the transition from shallow fresh water to deeper more saline, brackish water. USFWS salinity classification scheme will be used to characterize the salinity-depth profile. Surface waters will be classified with respect to salinity as follows (USFWS 1979):

- Fresh: Less than 0.5 parts per thousand (ppt)
- Oligohaline: 0.5 to 5 ppt
- Mesohaline: 5 to 18 ppt
- Polyhaline:18 to 30 ppt
- Euhaline: 30 to 40 ppt

When the salinity-depth profile indicates salinity concentrations are stratified (i.e., fresh over oligohaline) then water samples will be collected at the middle of each layer. If the salinity-depth profile indicates no vertical salinity gradient, then one surface sample will be collected from the middle of the water column. Phase I data salinity levels in Bayou d'Inde on average were 18 ppt (range from 11 to 28 ppt). Upper Calcasieu salinity levels on average were 20 ppt (range from 14 to 23 ppt) and the average Lower Calcasieu salinity levels were 24 ppt (range from 17 to 56 ppt). Salinity levels in SNWR during the Ecological Risk Assessment Reconnaissance were found to be on average around 9 ppt (range from 7 to 12 ppt).

The actual depth of collection may be adjusted based on the results of physical parameters measured onsite. Sample collection techniques are described in Section 4.0.

3.1.2 DATA GAP SAMPLE NUMBER AND LOCATION

Sediment and surface water samples collected from 10 sub-areas within the Calcasieu Estuary will include the following type and number of samples.

- 29 surface sediment samples will be collected from the 0 to 10-cm (0 to 4-in.) depth interval.
- 15 locations will be sampled from two discrete depth intervals 10 to 20-cm (4 to 8-in.) and 20 to 30-cm (8 to 12-in.) depth interval.
- A total of 14 surface water chemical samples will be collected. Surface water sample depths will be dependent upon salinity measurements at the location.
- 17 duplicates as well as 9 extra volume samples for matrix spike/matrix duplicate (MS/MSD) analyses; other aqueous QC samples are included in Section 3.6 (i.e., equipment rinsates).

A description of each sample, the sample coordinates, data use, sample container requirements, and analytical methods are summarized in Tables 3-2 and 3-3. The locations of the surface and multi-depth sediment samples are shown in Figures 3-1, 3-2 and 3-3 (Preliminary figure is provided.   Figure will be replaced with a final in the update). If a proposed sample location cannot be sampled because of an access limitation, obstruction, or some other technical difficulty, the sample will be relocated as close to the selected location as possible. New coordinates will be established.

3.1.3 DATA GAP SAMPLE ANALYTICAL PROTOCOL

Sediment and surface water samples collected from Phase II will be analyzed offsite. Three potential analytical laboratories will be used including a subcontract laboratory, PRPs laboratory, EPA's Regional (Region 6) Laboratory (Houston) and EPA Contract Laboratory Program (CLP).

The analytical protocol for sediments includes target analyte list (TAL) metals, SVOCs, PCBs (total and congener specific), pesticides, dioxin/furans, TCLP metals, and TCLP SVOCs. The analysis performed for each location is dependent upon the task it is to fulfill. Not all analytes will be characterized at each location. Surface water samples will be analyzed for total metals and SVOCs. Table 3-2 identifies contaminants to be analyzed for each location. Analytical protocols include EPA SW-846 (EPA 1997a) and/or EPA CLP standard methods, as listed in Table 3-3 and in Part II of this SAP. Onsite sediment field measurements will be limited to soil density (penetrometer) measurements, and oxidation/reduction potential (Eh).

3.2 SEDIMENT TRIAD INVESTIGATION

A sediment quality triad (Triad) assessment will be conducted to quantify risk associated with impacted sediments by organic and inorganic contaminants, support ecological risk assessment, and evaluate any potential future remedial actions in the Calcasieu Estuary. The Triad assessment integrates information on sediment toxicity, chemistry, and benthic community structure in an integrated weight of evidence approach (Ingersoll *et al.* 1997)**.** The sediment sampling strategy will provide both broad geographic coverage of the estuary and provide the data necessary to evaluate the SQGs. In total, 31 areas within the Calcasieu Estuary will be sampled, encompassing the 10 sub-areas and two reference areas. Five areas will be sampled in the reference areas. The data that will be generated in this sampling program will provide the information that is needed to develop site-specific linkages between sediment chemistry and biological effects in the estuary. As such, the results of the sampling program will facilitate estimation of probability of observing sediment toxicity and benthic invertebrate community alteration at the stations that were sampled in the Phase I program.

3.2.1 SEDIMENT TRIAD DESIGN STRATEGY

Based on the recommendation from the Ecological Risk Assessment (ERA) Workshop (Appendix C), a sediment quality triad (Triad) investigation will be conducted to evaluate the risks to sediment-dwelling organisms exposed to contaminated sediments. The Triad consists of:

- assessment of sediment and porewater toxicity,
- assessment of benthic invertebrate community structure, and
- chemical analysis of sediment and porewater.

The sediment sampling design strategy provides both geographic coverage of the estuary and provides the data necessary to evaluate the SQGs. In total, 31 triad reaches will be sampled, encompassing the 10 chemical investigation sub-areas and the reference areas, SNWR and Calcasieu Lake.

3.2.1.1 Classification of COPCs

To facilitate the development of conceptual models that link stressors to receptors for the triad investigation, the COPCs were classified into three groups based on their fate and effects in the aquatic ecosystem, including bioaccumulative substances; toxic substances that partition into sediments; and toxic substances that partition into water.

The classification of the COPCs within the Triad reaches is listed in Table 3-4.

3.2.1.2 Distribution of Sediment Sample Locations

The sampling program was designed by considering the distribution of various chemical characteristics in sediment (i.e., from the Phase I). As such, the Phase II sediment triad samples may have a range of chemical characteristics. The sediment sample locations were chosen so that the chemical concentrations are evenly distributed within four categories of sediment chemistry. The four categories are based upon the mean ERM quotient (ERM-Q) which is determined by the following equation:

$$avgERM-Q = \sum_n \left(\frac{COPCConcentration}{ERM_{COPC}}\right) \Big/ n$$

This targeted distribution of the sediment chemistry data will facilitate calculation of the incidence of toxicity within each category. These incidences of toxicity will be compared to the results that have been observed elsewhere in North America (Long and MacDonald 1998).

The locations of the sampling stations were determined using a quasi-stratified random sampling design. The study area and candidate reference areas were divided into roughly 50 reaches (or strata) using the available sediment chemistry data (i.e., historic data and Phase I data) and other relevant information. Each stratum typically represented a recognizable topographic feature, such as a lake, a waterway, or a portion of a waterway in which conditions were expected to be relatively consistent). In the lakes, deeper waters (> 1m) were excluded from consideration to facilitate co-location of the sediment sampling stations with the fish sampling stations.

Approximately 100 samples were distributed among the various reaches in a manner that provided broad geographic coverage of the study and reference areas. For each of the selected strata, the existing sediment chemistry data were then used to determine the probability of obtaining samples within each reach that fell into four categories of sediment chemistry (i.e., <0.1, 0.1 to 0.5, 0.5 to

1.5, and >1.5 of a mean ERM-Q, as noted in Table 3-5, and as calculated using the methods of Long and MacDonald 1998. The number of samples within each stratum that was predicted to fall within each of the four categories of sediment chemistry was then estimated by multiplying the number of samples that were distributed into the stratum by the previously determined probabilities. The number of samples assigned to each reach was subsequently adjusted, as necessary, to obtain roughly 20 samples for each category of sediment chemistry, see Table 3-6.

Following stratification of the study area, the exact locations of candidate sampling sites were identified using the FIELDS (Fully Integrated Environmental Location Decision Support system) tools for randomly selecting sampling locations. Using this procedure, each of the candidate sampling locations are determined independently and each position (represented by a geographic coordinate) has an equal probability of being selected. As such, each of the candidate stations are considered to be true replicates of the stratum.

To determine if the proposed sampling program would meet the needs of the project, a preliminary evaluation was conducted to predict the distribution of sediment chemistry at the 100 stations slated for sampling. In this evaluation, each of the selected sampling stations was plotted, together with the Phase I sampling station calculated ERM-Qs and associated historical sediment chemistry data.

For each selected sampling station, the three closest neighboring samples (within a 250 meter radius) for which sediment chemistry data was available were identified. The mean ERM-Qs for these neighboring samples were then determined and used to predict the chemical characteristics for the selected sampling station, see Table 3-7. If only one or two neighboring samples were available within the 250 meter radius, then these samples were used to predict the chemical characteristics for the selected sampling station. If no neighboring samples fell within the 250 meter radius, then the average mean ERM-Q for all the samples within the stratus was determined and used to predict sediment chemistry.

The predicted chemical characteristics for each of the selected sampling stations were used to estimate the distribution of the Phase II sampling program results within the four categories of sediment chemistry. The result of this preliminary evaluation indicates that the probable distribution of the sediment chemistry data will likely support the assessment of the predictive ability of the SQGs. More specifically, the current evaluation suggests that approximately 18 samples will have mean ERM-Qs of <0.1, approximately 19 samples will have mean ERM-Qs of 0.1 to 0.5, approximately 42 samples will have mean ERM-Qs of 0.5 to 1.5, and approximately 20 samples will have mean ERM-Qs of >1.5, see Table 3-8. This sample location distribution meets the target distribution, resulting in roughly 20 samples within each of the four categories of sediment chemistry.

3.2.1.3 Reference Areas

Reference areas were selected to represent estuarian conditions minimally impacted by contaminants. The reference areas represent background conditions of the various media. Specific sampling locations were determined by examining historical data and locating areas that had similar water and presumably sediment conditions to those of Calcasieu Estuary.

3.2.2 SEDIMENT TRIAD NUMBER AND LOCATION

Triad samples collected from the Calcasieu Estuary will include the following type and number of samples.

- Sediment samples will be collected from 100 sediment Triad locations from the 0 to 10-cm (0 to 4-in.) depth interval in the Calcasieu Estuary for toxicity testing and chemical characterization.

- Physical, water quality parameters [e.g. temperature, pH, conductivity, salinity, oxidation/reduction potential (ORP), dissolved oxygen, and turbidity] will be measured at all 100 sediment Triad locations.

- Porewater samples will be collected from 50 locations for full chemical characterization and toxicity testing.

- Porewater samples will be collected from 50 locations for partial chemical characterization.

- Samples for benthic community evaluation will be collected from 100 Triad sampling locations.

- A total of 8 duplicates at 5%, as well as 4 extra volume samples for MS/MSD analyses collected at 2%; other aqueous QC samples are included in Section 3.6 (i.e., equipment rinsates).

The location of the Triad samples are shown in Figures 3-4, 3-5, and 3-6 (Draft Figure 3-4 to 3-6 1 and Draft figure 3-4 to 3-6 2).

3.2.3 SEDIMENT TOXICITY AND BENTHIC COMMUNITY SURVEY PROTOCOL

Ecological sediment samples collected from the Calcasieu Estuary, SNWR and Lake Calcasieu will be analyzed for sediment toxicity, benthic community structure, and sediment chemistry by subcontracted laboratories. All tests will be in accordance with nationally recognized protocols established by USEPA (2000a) and ASTM (2000a). A description of each sample, the sample coordinate, data use, sample container requirements, and analytical methods are summarized in Tables 3-2 and 3-3.

3.2.3.1 Sediment toxicity testing

A variety of standard methods have been developed for assessing the toxicity of contaminants associated with whole-sediment samples using amphipods, midges, polychaetes, oligochaetes, mayflies, or cladocerans (USEPA 1994, 2000a; ASTM 2000a-d; Environment Canada 1997a,b). Several endpoints are suggested in these methods for measuring effects of contaminants in sediment including survival, growth, behavior, or reproduction; however, survival of test organisms in 10-day exposures is the endpoint most commonly reported. These methods have been applied to a variety of sediments to address issues ranging from site assessments to bioavailability of organic and inorganic contaminants using field-collected and laboratory-spiked samples.

Short-term exposures with whole-sediment samples which only measure effects on survival can be used to identify adverse affects of high levels of contamination; however, these exposures may not be able to identify marginally contaminated sediments (Benoit *et al.* 1997; Carr *et al.* 1996a,b; Carr *et al.* 2000; Ingersoll *et al.* 1998; USEPA 2000b). Chronic toxicity tests which measure sublethal effects of contaminants associated with sediments have recently been described by USEPA (2000a) and ASTM (2000a). Application of these chronic methods has demonstrated more than a 6-fold increase in the sensitivity of the chronic tests measuring survival and growth in 28-day exposures compared to 10-day acute toxicity tests (USEPA 2000b).

Sediment tests have also been developed which measure chronic sublethal responses in organisms exposed to sediment porewater including tests with fertilization and embryological development assays with echinoderms (Carr *et al.* 1996a,b; Carr *et al.* 1997), fish (Carr and Chapman 1992), and algae (Hooten and Carr 1998). Porewater will be extracted from the sediment at the Triad investigations by a centrifuge.

In support of the Calcasieu Estuary Triad design whole-sediment toxicity tests will be conducted at 100 locations. Whole sediment toxicity tests will include:

- 10-day survival and growth exposures with the amphipod *Hyalella azteca;*
- 10-day survival tests with the amphipod, *Ampelisca abdita;*
- 28-day survival and growth tests with *H. azteca*; and,
- Bioluminescence tests with Microtox®, *Vibrio fisheri*.

Methods for conducting these tests will follow standard procedures described in USEPA (2000a) and ASTM (2000a) at an overlying water salinity of 10 ppt. Solid-phase methods for conducting sediment microbial assays with Microtox® will also be applied to each sediment sample to quantify potential effects on decomposers in sediments (USEPA 1999). The Microtox® toxicity test system exposes luminescent bacteria to increasingly concentrated solutions of test sample. Reductions in the light output of the microorganisms reflecting the toxicity of the sample are monitored in a temperature-controlled photometer.

The Microtox® solid-phase test exposes glowing luminescent bacteria (*Vibrio fisheri*; B-NRL 1117, Microbics Corp.,Carlsbad, California in the stationary growth phase directly to sediment-bound chemical contaminants in an aqueous suspension of the test sample (Johnson and Long 1998). Bacteria are placed with solid-phase NaCl diluent in a solid-phase test tube, stirred with a vortex mixer, and used to prepare a 12 tube 1:2 dilution series. The sample is then blended and incubated for 20 min at 15^{o}C. A supernatant containing treated bioluminescent bacteria is transferred into standard cuvettes and placed in a temperature-controlled luminometer for a 5 minute stabilization period before light emissions are read. The endpoint measured in the solid-phase test with Microtox® is the EC_{50} (expressed as sediment wet weight/mL).

For the Microtox® test, summary EC_{50} values will be reported as the mean of three replicates, with variability expressed as the standard deviation. A toxicity reference index (TRI) will be used to determine when a chemical contaminant was toxic in the Microtox® tests, (when a potential pollutant is harmful to the bioluminescent bacteria). The control sediment will be spiked with 10 : g/mg equivalent/mL pentachlorophenol (PCP) using procedures described in Johnson and Long (1998). Results of these spiking studies will be used to develop a TRI. A sample spiked with PCP will generate an EC_{50} value and will be assigned a TRI of 1.0. A sample with an EC_{50} value less than that of the spiked sample would have a TRI > 1.0 indicating the sample was more toxic than the model toxicant. For example, an EC_{50} value of 0.25 mg/mL and TRI of 2.0 (spiked sample EC_{50} value/ test sample EC_{50} value = 0.5/0.25) indicates that this sample would be approximately two-fold more toxic than the PCP-spiked sample. Sediment samples will be designated toxic or non-toxic using this criterion for the TRI. Pentachlorophenol has been selected as a reference toxicant because of its ubiquity, known toxicity, and high K_{ow} value.

Porewater toxicity tests will be conducted on 50 sampling locations in support of the weight of evidence approach. Porewater toxicity tests will to be conducted will include:

- Fertilization and development assays with the sea urchin, *Arbacia punctalaia*;
- Germination assays with the macrophyte, *Ulva spp.*; and
- Embryo-larval assays with red drum, *Sciaenops ocellatus*.

Results of reference toxicant tests with red drum will be used to compare the sensitivity of this surrogate organism to other fish species of concern in the Calcasieu estuary (e.g., killifish, menhaden). Porewater toxicity tests with the marine macrophyte alga (*Ulva* spp.) will be conducted to measure effects on germination and growth. Methods for conducting porewater tests will follow procedures described in Carr *et al.* (1996a,b; 1997) and Hooten and Carr (1998). Selection of these whole-sediment and porewater toxicity tests is based on the availability of thoroughly described methods and a demonstrated sensitivity to contaminants of concern in sediments.

3.2.3.2 Benthic community surveys

Benthic macroinvertebrate abundance, community composition, and ecological function have long been used to characterize water quality in freshwater (Canfield *et al.* 1996, 1998) and marine ecosystems (Weisberg *et al.* 1997). Numerous studies have documented changes in benthic invertebrate community composition resulting from sediment contamination (USEPA 2000a). The aquatic ecosystem is linked together by virtue of interdependent trophic levels. Organisms near or in the sediment can be adversely affected by contaminants. This observation has led to ecological models providing a scientific basis for interpreting data in benthic monitoring and pollution assessment studies. These models utilize many single indicator species, community studies, and statistical approaches, but most are based on the concept of succession proposed by Rhoads *et al.* (1978) and Pearson and Rosenberg (1978). Succession theory states that good sediment quality is defined by a deeply distributed and highly diverse community containing equilibrium species. Communities with high biomass, diversity, and abundance in the deeper sediment sections indicates high quality. In contrast, communities with high abundance, low diversity, and limited to surface sediments are considered disturbed. Presence of a variety of feeding guilds also reflects high species diversity and has been shown to correspond with succession theory (Ranasinghe *et al.* 1994).

More recently it has been found that when assessing sediment contamination, it may not be adequate to study single components of the ecosystem. Ecological risk assessments of sediment contamination using laboratory toxicity tests, sediment chemistry, and measures of benthic macroinvertebrates as part of the Triad provides a more definitive assessment (Chapman *et al.* 1997). The spatial and temporal distribution of benthic organisms can be used to determine the degree to which chemicals in sediments are bioavailable and toxic.

Field surveys of macroinvertebrates provide an important component of biological assessments of toxicity associated with contaminated sediments for several reasons: (1) macroinvertebrates are abundant, diverse, relatively sedentary, easy to collect, and ubiquitous across a broad array of sediment types, (2) benthic organisms complete all or most of their life cycle in the same aquatic environment serving as continuous monitors of sediment quality, and (3) assessment of indigenous populations may be useful for quantifying resource damage.

The usefulness of benthic macroinvertebrate field studies for assessing sediment contamination has been limited by several factors, which must be accounted for in the sampling design: (1) the composition of benthic macroinvertebrate communities has been difficult to relate to individual chemical concentrations, (2) in addition to contaminants benthic macroinvertebrates respond to biotic and abiotic factors, and (3) large numbers of samples are typically needed to address the high variance associated with distribution of benthos.

Sediment samples for benthic invertebrate community structure will be collected by hand-held cores (Montagna and Kalke 1992). The cores are 6.72 cm diameter, covering an area of 35.4 cm^2. The cores are sectioned (at 0 to 3 cm, and 3 to 10 cm) to examine vertical distribution of macrofauna. Five replicates are taken per station. Each section replicate is placed in a polyethylene container, and fixed with 5% buffered formalin. In the laboratory, macrofauna are extracted using a 0.5 mm sieve, and removed by hand sorting. The retained organisms are identified to the lowest possible taxa (generally species) and counted. Biomass is measured by combining the organisms into the following higher taxonomic groups:

- Crustacea,
- Mollusca,
- Polychaeta,
- Nemertinea,
- Ophiuroidea, and
- Others, which includes all other rare taxa.

Species diversity will be calculated by replicate and by pooling all replicate cores for each station.

3.2.3.3 Sediment Chemical Characterization

Numerical SQGs have been developed by a variety of federal, state, and provincial agencies across North America using matching sediment chemistry and biological effects data. These SQGs have been routinely used to interpret historical data, identify potential problem chemicals or areas at a site, design monitoring programs, classify hot spots and rank sites, and make decisions for more detailed studies (USEPA 1996; Long and MacDonald 1998; Long *et al.* 1998a,b; Field *et al.* 1999). Additional suggested uses for SQGs include identifying the need for source controls of problem chemicals before release, linking chemical sources to sediment contamination, triggering regulatory action, and establishing target remediation objectives (USEPA 1997). Numerical SQGs, when used with other tools such as sediment toxicity tests, bioaccumulation, and benthic community surveys, can provide a powerful weight of evidence for assessing the hazards associated with contaminated sediments (Ingersoll *et al.* 1997).

The results of recent investigations demonstrated that the consensus-based SQGs provide a unifying synthesis of the existing guidelines, reflect causal rather than correlative effects, and account for the effects of contaminant mixtures in sediment (Swartz 1999, MacDonald *et al.* 2000a,b). Chemical characterizations of whole-sediment and porewater samples from the estuary will be used to evaluate the ability of SQGs to predict toxicity of sediment samples. Additional parameters will be analyzed in the sediment such as acid volatile sulfide and simultaneously extracted metals (AVS/SEM), total organic carbon (TOC) and grain size. AVS/SEM may be used as an indicator of metal availability and sediment toxicity. TOC is an important factor in determining the availability of hydrophobic organic contaminants and metals (USEPA 1994). Grain size data are useful in determining the geographic extent of sediment deposition zones and layers and perhaps their origin, and provides a quick method to make initial determinations as to the potential contaminant load of the sediments, with finer-grained sediments typically more contaminated than the sandy, coarser-grained fraction (USEPA 1994).

Chemical characterizations to be completed on each whole-sediment sample will include: TOC, grain size, AVS/SEM (Copper, Zinc, Lead, Cadmium, Nickel and Silver), total recoverable metals, SVOCs, methyl mercury, PCBs (congeners and aroclors), and organochlorine pesticides. A portion of the samples will also be analyzed for dioxins/furans. Chemical characterization to be completed on 50 porewater samples that will be used for toxicity testing includes: salinity, hardness, dissolved organic carbon, total recoverable and dissolved (filtered) metals, ammonia, hydrogen sulfide, methyl mercury, SVOCs, and PCBs. On the other 50 samples, only salinity, hardness, ammonia and hydrogen sulfide will be measured in porewater.

3.3 TISSUE SAMPLING

Tissue samples will be collected and analyzed for chemical characterization for human health and ecological risk assessment evaluations. Data will be used to assess risks to fish and wildlife resources and to human health. Sample data will also support the feasibility study and potential future remedial actions. Biota tissue samples will be collected in three AOCs in the Estuary (Upper Calcasieu, Bayou d'Inde, and Lower Calcasieu) and in the reference areas (SNWR and Calcasieu Lake).

3.3.1 TISSUE DESIGN STRATEGY

An Ecological Assessment Site Reconnaissance sampling program of fish and invertebrate tissues was conducted in spring 2000. This sampling program included a number of fish and invertebrate species, although a few large, predatory fish species dominated the dataset (e.g., black drum). Samples were taken from a number of sub-areas within the Bayou d'Inde, Upper Calcasieu and Lower Calcasieu AOCs, and the SNWR. Each sample was analyzed for a broad suite of metals and organic chemicals, and a subset of samples was analyzed for dioxin and furans. For some of the organic chemicals (e.g., the aroclors), the detection limits were orders of magnitude above levels associated with effects to wildlife (Moore *et al.* 1999). Thus, the Phase II sampling program will serve two purposes: (1) the data will be used in a screening level ecological risk assessment (SERA) to update which chemicals and locations potentially pose risks to the wildlife assessment endpoints identified at the recent workshop (MacDonald et al. 2000), and (2) the data on chemical levels in fish and invertebrate tissues will be used as inputs to wildlife exposure models in the BERA and for human health risk assessment.

The following ecosystem objectives were established at the BERA workshop (MacDonald et al. 2000, Appendix C) that have direct relevance to the design of the Phase II sampling program:

- Maintain and, if necessary, restore aquatic environmental conditions that will support a healthy and diverse fish community;

- Maintain and, if necessary, restore aquatic, wetland, and terrestrial habitats that will support healthy, diverse, and self-sustaining populations of aquatic dependent avian species; and

- Maintain and, if necessary, restore aquatic, wetland, and terrestrial habitats that will support healthy, diverse, and self-sustaining populations of aquatic dependent mammalian species.

The fish and wildlife species that are the focus of this assessment range from relatively small predators with limited foraging ranges (e.g., kingfishers) to large predators with broad foraging ranges (e.g., black drum, dolphins). Several wildlife focal species are also highly opportunistic feeders (e.g., raccoons, mink). Potential prey species are highly variable in terms of their preferred habitat (e.g., sheltered bayous versus open water), size, mobility, and foraging range. The point estimates or distributions that will be developed in the BERA for prey tissue concentrations in the wildlife exposure models need to be appropriately scaled. For example, kingfishers have small foraging ranges and feed on small fish, which themselves have small ranges. The prey of the kingfisher will exhibit high spatial variability in tissue residues depending on proximity to contaminant source. Because neither the kingfisher nor its prey spatially average their exposures, separate exposure analyses will be required for kingfishers inhabiting different sub-areas in the Calcasieu Estuary. Conversely, for wildlife species that forage widely (e.g., dolphins) on prey that themselves spatially average their exposures (e.g., black drum), a single exposure analysis for the estuary would suffice. These two examples would require different Phase II sampling designs. For kingfishers, it would be necessary to sample small fish from a number of locations using a "randomized block" design (i.e., x randomly chosen samples from each of y sub-areas the size of the sub-area scaled approximately to the foraging range of kingfishers). For dolphins, it would be necessary to randomly sample large fish from the entire estuary.

Two approaches were used to develop a Phase II sampling design. Considering the feeding ecology of the fish and wildlife focal species and attempt to determine likely prey species (or types), and their likely foraging areas. A statistical analyses was conducted on the tissue residues data collected during the Phase I sampling program. The objective of these analyses were to determine numbers of samples that need to be collected in Phase II to reliably develop measures of centrality and variability over the spatial scales of interest for the different predator-prey combinations. The statistical analyses, however, are somewhat limited because the Phase I data set is dominated by non-detects as a result of the above-mentioned problem of high detection limits for many of the organic chemicals (e.g., aroclors, dioxins, and furans). Also, the Phase I data set has insufficient sample sizes for invertebrates and small fish species to permit useful statistical analyses. This design combines these two approaches for the Phase II sampling program in the Calcasieu Estuary.

3.3.1.1 Prey Sampling Strategy

The selected prey species can be organized into four logical groups each reflecting a particular combination of size range, pelagic versus demersal distribution in the water column, trophic level, and foraging range. The sorting criteria and the resulting prey groups are discussed below. The grouped prey species are shown in Table 3-6.

Body Size

Fish and invertebrate species found in the southern USA vary widely in terms of body size. They range from tiny gobies (Gobiidae) less than a centimeter in length to alligator gars and drums that are up to 2 to 3 meters in length. Most local fish, however, are about one-quarter to one-half meter long.

Water Column Distribution

The estuarine habitat such as that found in Southern Louisiana favors demersal fish. Tidal, coastal, swampy or marshy areas tend to be shallow and have mostly muddy bottoms that provide a good substrate and source of food for demersal fish prey items such as crustaceans, annelids, molluscs, and algae. The majority of fish species listed for this geographic location are bottom fish. Examples include catfishes (Ariidae), blennies (Bleniidae), suckers (Catostomidae), some killifish (Fundulidae), gobies (Gobiidae), wormfishes (Microdesmidae), flounders (all families), and Rockfishes (Sebastidae).

Pelagic fish include silversides (Atherinidae), sunfishes (Centrarchidae), herrings (Clupeidae), pupfishes (Cyprinodontidae), anchovies (Engraulidae), killifishes (Fundulidae), gars (Lepisosteidae), mullets (Muglidae), poecilids (Poecilidae), and drums (Sciaenidae).

Trophic Level

The trophic level is the amount of energy, in terms of food, that an organism needs. Organisms capable of utilizing inorganic chemicals, e.g., plants, or food of low energy content are said to be on a low trophic level whereas, for example, predator species needing food of high energy content are said to be on a high trophic level. The trophic level number, indicates the level of the organism in the food chain (WHO, 1979).

The selected set of fish and invertebrate species includes a mix of feeding strategies and prey or food items. This has the effect of giving a wide range of trophic level values. Prey species at different trophic levels are likely to have substantially different levels of bioaccumulative chemicals in their tissues. There are prey species that are exclusively phytoplanktivores such as herring, shad, sardine, and menhaden (Clupeidae). There are also purely carnivorous species such as blue crab, bass (Centrarchidae), anchovy (Engraulidae), gar (Lepisosteidae), and most sebastids (Sebastidae). Most of the reported species, however, are omnivores.

The trophic level for planktivores is low at 2.0. For omnivores, it ranged from 2.1 for mullets (Muglidae) to 3.4 for silversides (Atherinidae) and pupfishes (Cyprinodontidae). Carnivores may have even higher levels.

Foraging Range

The foraging range of each prey species is a combination of foraging strategy, diet requirements, and body size. A general observation is that larger fish tend to travel more than do the smaller fish, crabs and clams. The latter group tends to find suitable habitat in quiet bays and inlets and tend to remain there, whereas larger fish are more likely to enter open water and travel extensively in search for food. There are exceptions to this observation. Anchovies, for example, tend to be small, yet they cover large distances. On the other hand, gars can be very large yet tend to move little. Species with large foraging ranges are likely to exhibit less spatial variation in tissue residues than will species with small foraging ranges.

Prey Groups

The following five groups represent the range of prey species likely to occur in the Calcasieu Estuary. For the Phase II sampling program, species within a particular group are interchangeable because predators will be unlikely to have distinct preferences for one species over another within a group. It is also expected that tissue residue levels will be similar between species within a group, providing they are collected in the same area.

Group 1. Small bentho-pelagic fish and small benthic invertebrates that inhabit shallow water and have a localized distribution. The trophic level ranges from 2 to 2.5. Tissue residue levels are expected to vary substantially depending on proximity to sources.

Group 2. Small pelagic fish that inhabit water of any depth and have a broad distribution. The trophic level ranges from 2 to 2.5. Tissue residue levels are not expected to vary widely between sub-areas in the Calcasieu Estuary.

Group 3. Large pelagic fish that inhabit water of any depth and have a broad foraging range. The trophic level ranges from 2 to 2.5. Tissue residue levels are not expected to vary widely between sub-areas in the Calcasieu Estuary.

Group 4. Medium to large bentho-pelagic fish that inhabit water of any depth and have a broad foraging range. The trophic level ranges from 2.5 to 3.5. Tissue residue levels are expected to be quite high for bioaccumulative chemicals but are unlikely to vary widely between sub-areas in the Calcasieu Estuary.

Group 5. Large pelagic fish that inhabit shallow water and have a local distribution. The trophic level ranges from 2.5 to 3.5. Tissue residue levels are expected to be quite high for bioaccumulative chemicals in contaminated sub-areas in the Calcasieu Estuary. Otherwise, levels will be lower.

Each of the fish and wildlife focal species for the estuary tend to feed upon one, or at most, two of the above prey groups. The majority of the fish and wildlife focal species feed upon prey in group 1, although several species also feed upon prey in group 2, 3, and/or 4.

3.3.1.2 Sample Size Rationale

The sample size for the Phase II tissue sampling is based upon the following:

- Sampling of small fish and invertebrates that tend not to move around much (i.e., group 1) is a crucial component of this sampling program to develop credible exposure estimates for most of the fish and wildlife focal species for ecological risk. The species will exhibit considerable spatial variation across the Calcasieu Estuary so there is a need to concentrate on obtaining sufficient samples from each of a number of sub-areas. The results from this kind of detailed sampling will permit development of separate exposure estimates in different sub-areas for individuals of focal species with small foraging ranges (e.g., kingfishers).

- Sampling of fish species that move around a lot (i.e., groups 2 - 4) is also required for some wildlife focal species (e.g., osprey, dolphin). These species will exhibit less spatial variation across the Calcasieu Estuary and thus the sampling program will not require detailed sampling at the sub-area spatial scale. For these groups, it should be sufficient to obtain samples at a higher level of resolution (e.g., Upper Calcasieu, Lower Calcasieu, Bayou d'Inde) for both ecological and human health risk assessment.

- No sampling of group 5 fish species (i.e., gars) is required for the ecological risk assessment.

- Sampling from groups 4 and 5 for fillets only will be necessary for human health risk assessment.

3.3.1.3 Sample Collection

Sampling locations for tissue collection have been pre-determined based upon the randomly generated Triad locations. At each of the stations (Table 3-10), multiple samples of group 1 fish and invertebrates (i.e., 3 to 5 samples of each sub-group) will be collected within a 100 meter radius of the designated coordinates. The dimensions of each station will be expanded to 500 meters for collecting groups 2, 3 and 4 fish samples (Table 3-11). The coordinates of alternate sampling stations are also identified if the primary sampling station do not yield sufficient sample. Figures 3-4, 3-5, 3-6 (Draft Figure 3-4 to 3-6 1 and Draft Figure 3-4 to 3-6 2) identify locations for tissue collection, Table 3-12 identifies sample locations and numbers of samples per species group.

3.3.2 BIOTA TISSUE SAMPLE LOCATION AND NUMBER

An evaluation of previous fish data collected within the estuary was conducted using standard statistical methods to determine the number of fish samples to be collected during Phase II to support the ecological and human health risk assessment. Figures 3-7 through 3-9 show power curves for mercury and copper in black drum and dieldrin in flounder at selected locations. The statistical power of detecting a given difference (shown in the legend in log units) is plotted against sample size. The power estimation is based on a significance level of 0.05 and we assume that chemical concentration follows a log-normal distribution. These curves are usually used as the basis for determining sample size. For example, a sample size of 50 is needed in order to test a log difference of 0.3 (i.e., factor of 2) for mercury concentration in black drum with a power of 0.80. Using the three selected species-chemical comparisons, a minimum of 20 samples is necessary to achieve a power of 0.8 with a modest log difference of 0.3.

- A cumulative total of 240 whole body samples are required from groups 2, 3 and 4 (20 samples per group) from Bayou d'Inde, Upper Calcasieu, Lower Calcasieu and Calcasieu Lake. These samples will be for ecological risk assessment needs. Depending on size, samples from group 2 may need to be composited.

- A cumulative total of 276 whole body samples are required from group 1 fish and 164 invertebrates from Bayou d'Inde, Upper Calcasieu, Lower Calcasieu and Calcasieu Lake. Collection of invertebrates, when possible, should have equal numbers of bivalves, small crabs, and other invertebrates (i.e., polychaetes). These samples will be for ecological risk assessment needs. Samples from this group will likely need to be composited.

- A total of 30 fillet samples are required from either group 4 or 5 from Bayou d'Inde, Upper Calcasieu, Lower Calcasieu and Calcasieu Lake. A total of 90 samples are required from group 4 or 5. These samples will be for human health risk assessment needs. Target species in these groups are black drum, sea trout, flounder, and gar. All species collected will be within the Louisiana legal catch limits. Collection of fillet samples should have equal number among the species.

- A total of 65 duplicates (i.e., at 10%), as well as 33 extra volume sample for MS/MSD analyses (i.e., at 5%) will be collected and other aqueous QC samples are discussed in Section 3.6 (i.e., equipment rinsates).

The length of the fish is generally dependent on its age. Its age is related to the potential for exposure to site contaminants. Therefore, to obtain tissue samples with the highest potential exposure analysis for human health data needs, fish samples should be of a minimum length, within the Louisiana legal catch limits. The following are the required minimum lengths for human health:

- Black drum shall be a minimum length of 37cm.
- Sea trout shall be a minimum length of 15 cm.
- Flounder shall be a minimum length of 11 cm.

3.3.3 BIOTA TISSUE SAMPLE ANALYTICAL PROTOCOL

Biota tissue samples collected from the Calcasieu Estuary and SNWR will be analyzed offsite. A subcontract laboratory and/or a PRP laboratory will be used to analyze for chemicals of interest. The analytical protocol includes TAL metals, SVOCs, PCBs, PCB congeners, pesticides, and dioxin/furans. Dioxin/furans and PCB congeners analysis will be limited to 20% of the total biota samples collected. Table 3-2 identifies contaminants to be analyzed for each location. Analytical protocols include EPA SW-846 (EPA 1997a), and USGS and EPA CLP standard methods, as listed in Table 3-3 and in Part II of this SAP.

3.4 SOIL SAMPLING

Soil samples will be collected from confined disposal facilities (CDFs) and analyzed for COPCs to assess the areas potential contribution to the estuary and to support risk assessment evaluations and the FS. Soil samples will be surface composite samples (i.e., 0 to 15-cm [6-in] depth).

3.4.1 DESIGN STRATEGY

CDFs contain sediment dredged from the Calcasieu River which may contain the COPCs. Runoff and/or groundwater infiltration may contribute to contamination in particular areas of the estuary. The rationale for sampling the CDFs is to characterize the presence of COPCs and based upon those findings and visual observations of each facility, evaluate their potential for contribution of contaminants to the estuary.

The CDFs to be sampled are located along the ship channel from Moss Lake up to Lake Charles. Sample locations on the CDF were determined by sectioning off 6 grids and generating a random sample location within each individual grid. The soil samples from each CDF will be composited into one sample. Each composite location will have a GPS coordinate that will be used to locate the sample location. Additional locations maybe be sampled based upon visual observation of the CDF. These samples will not be included with the composite samples and will be located in areas of stressed vegetation, erosion, or staining.

3.4.2 SOIL SAMPLE NUMBER AND LOCATION

Soil samples will be collected and analyzed to characterize CDFs located in the Calcasieu Estuary. Thirteen CDFs have been identified for sampling and are shown in Figure 3-10 and will include the following type and number of samples.

- A total of 13 random grid soil samples composited into one sample (one from each of the 13 CDFs) will be collected from the 0 to 15-cm (0 to 6-in) depth interval.

- A total of 6 opportunistic samples will be collected in potentially impacted areas as evidenced by stressed vegetation, erosion, or staining. Samples will be collected from the 0 to 15-cm (0 to 6-in) depth interval.

- A total of 2 duplicates (i.e., at 10%), as well as 1 extra volume sample for MS/MSD analyses will be collected; other aqueous QC samples are discussed in Section 3.6 (i.e., equipment rinsates).

A description of each sample, sample container requirements, and analytical methods are summarized in Table 3-3. The location of sample locations is shown in Figure 3-10. If a proposed soil sample location cannot be sampled because of access limitations, obstructions, or some other technical difficulty, the sample will be relocated as close to the selected location, as possible. GPS locations will be recorded at each composite location.

3.4.3 SOIL SAMPLE ANALYTICAL PROTOCOL

Composite and opportunistic soil samples collected from the CDFs will be analyzed offsite. Four potential analytical laboratories will be used including a subcontract laboratory, a PRPs laboratory, EPA's Regional (Region 6) Laboratory (Houston), and EPA's CLP laboratories. The analytical protocol includes TAL metals, SVOCs, PCBs, pesticides, TCLP metal and TCLP SVOCs. Table 3-13 identifies contaminants to be analyzed for each location. Analytical protocols include EPA SW-846 (EPA 1997a) and EPA CLP standard methods, as listed in Table 3-3 and in Part II of this SAP. Onsite field measurements will be limited to soil density (penetrometer) measurements and oxidation/reduction potential.

3.5 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

QA/QC samples will include equipment rinsate blanks (Table 3-3) and duplicates for samples undergoing chemical analysis. The number of method-required MS/MSD volumes are included in Table 3-3. The number of QA/QC samples collected during the field investigation for both sediment samples includes:

- Ninety-nine QC samples, including 15 equipment rinsate blanks and 84 duplicates. Forty-three MS/MSD samples will also be provided.

The frequency of collection is described in Section 5.4.2.4.

3.6 INVESTIGATION-DERIVED WASTE SAMPLING

IDW includes wash and rinse water from the equipment decontamination process and possibly excess sediment from toxicity testing (Section 4). The excess sediment from toxicity testing will be from sediment that the testing labs that can not adequate dispose of material. All remnant sample volume will be rinsed into the surface water at the specific sampling location. The IDW generated during the field investigation will be contained for future disposal. Representative composite samples will be collected from aqueous waste stream containers for disposal characterization. Characterization will identify concentrations of constituents in the waste streams for comparison to regulatory disposal standards. These analyses will determine whether or not the wastes are considered characteristically hazardous.

A total of 5 IDW samples will be collected from the aqueous streams (Table 3-3). The samples will be composites, as described below. No QC samples will be collected or analyzed for this media.

Representative aliquots will be collected from the aqueous IDW container and composited into three samples; one-third of the aliquots per sample. Personal protective equipment (PPE) will not be retained as IDW and, instead, these materials will be decontaminated then disposed as municipal waste. The IDW will be analyzed for Resource Conservation and Recovery Act (RCRA) metals, SVOCs, pesticides, and PCBs (Table 3-3). The aqueous samples will not be filtered and, therefore, the analytical results will reflect total metal concentrations.

4.0 FIELD ACTIVITY METHODS AND PROCEDURES

The following is a summary of field activities that will be performed by CDM Federal personnel and/or subcontractors for the Calcasieu Estuary Phase II RI sampling event:

- Subcontractor procurement.
- Site mobilization/demobilization.
- Site access, ingress, and egress.
- Utility clearance.
- Surveying.
- Equipment, supplies, and containers procurement.
- Sediment sampling.
- Surface water sampling.
- Biota sampling.
- CDF soil sampling.
- Benthic community surveys.
- Field instrumentation operation and maintenance.
- Equipment decontamination.
- IDW management and storage.

All field activities will be conducted in accordance with the site-specific Health and Safety Plans (HASP) (Appendix A). The proposed field activities described in Section 4.0 reference CDM Federal SOPs, where applicable, or provide site-specific procedures if there are no applicable SOPs. Referenced SOPs are included in Appendix B. The “Baseline Ecological Risk Assessment Workshop” Summary Report is located in Appendix C. Specialized equipment that may be used during the field work is presented in Appendix D. Forms that may be used during the field investigation activities are included in Appendix E. EPA’s CLP sample handling requirements are included in Appendix F.

4.1 SITE MOBILIZATION AND DEMOBILIZATION

CDM Federal will identify and provide all necessary personnel, equipment, and materials for mobilization to and demobilization from the site for the purpose of conducting the Phase II field investigation. A temporary site office has been established at the Bowtie Marina on Bayou Contraband located at 1245 Giovanni Street, northwest of the intersection of Interstate Highway 210 (I-210) and Lake Street. The site office will serve as the command center for all field operations.

Equipment procurement includes ordering and purchasing of equipment and supplies. An equipment list has been prepared and any equipment not maintained in inventory will be obtained (Section 4.4). One additional unit of critical field monitoring instruments, such as pH meters, salinity meters, and photoionization detectors (PIDs) will be maintained onsite in case of instrument malfunction or damage.

A decontamination pad and IDW staging area have been established near the site office. A portable decontamination area may also be set up on the boats because of the remoteness of portions of the study area.

Full demobilization may be conducted after the sampling event. Rented field equipment will be returned, the field site trailer will be removed from the site, utilities disconnected, and personnel will leave the site.

4.2 ACCESS AND SAMPLING PERMISSION

CDM Federal and their subcontractors will identify necessary access and permit requirements prior to field crew mobilization. From the Phase I investigation, CDM Federal has identified private property owners for Bayou d'Inde which are listed in Table 4-1. Unrestricted passage to all proposed sampling locations may not be possible via boat. Access to private roads and other throughways may be needed for sampling and/or equipment or sample transfers.

CDM will review access requirements with EPA. EPA will be notified of all private property access needs approximately two weeks prior to mobilization. EPA will be responsible for contacting the property owners and formally arranging site access. CDM has a copy of Phase I access agreements, additional access agreements deemed necessary under the Triad approach will be coordinated by CDM and obtained through EPA. A copy of all access agreements will be provided to CDM a minimum of three days before sampling begins. CDM will coordinate with individual private property owners concerning specific sampling dates once formal access agreements are received.

4.3 UTILITY CLEARANCES

Utilities and submerged pipelines will be located before any intrusive subsurface sampling activities are performed. Utility clearances will be obtained by calling Louisiana One Call and private property owners to ensure that no underground utilities exist at the proposed sampling sites. In addition, the U.S. Coast Guard will be notified of the sampling, as appropriate. If underground or submerged utilities are present at a specific sampling location, the sampling location will be moved to avoid the utility.

4.4 EQUIPMENT, SUPPLIES, AND SAMPLE CONTAINERS

Table 4-2 lists equipment and supplies necessary to support the field sampling activities. This table separates field items into the following categories; sampling, health and safety monitoring, equipment and personal decontamination, and general field operations.

A portion of the sample containers, preservatives, and coolers needed to collect and contain environmental samples designated for analyses will be provided by the subcontractor laboratories, if applicable. All sample containers will be pre-cleaned, documented and traceable to the group or facility that performed the cleaning. Sampling containers will not be cleaned or rinsed in the field. A list of specific containers and preservatives by analytical method is included in Tables 3-3 and 5-4.

4.5 SURVEYING

All locations were determined prior to field effort and designated with Universal Transverse Mercator (UTM) coordinates (Table 3-3). A differential global positioning system (GPS) receiver and base station will be used to locate the sample stations. Surveying information will be managed in a database and available for base maps and data reports. One field sampling team member will be responsible for locating and managing the surveying data. Actual UTM coordinates will be established at each sample location.

4.6 SEDIMENT SAMPLING

Both surface and multi-depth sediment samples will be collected from the Calcasieu Estuary. Surface sediment (Section 4.6.1) will be collected from 0 to 10-cm (0 to 4-in) deep. Multi-depth samples (Section 4.6.2) will be collected from depth intervals of 10 to 20-cm (4 to 8-in) and 20 to 30-cm (8 to 12-in). The lithology of the sediment will only be noted at the multi-depth locations since it was performed on the surface sediment during Phase I. The lithology will be described and recorded in accordance with CDM Federal's SOP 3-5, Lithologic Logging (Appendix B). Field forms are included in Appendix E. Because of the sample volume needed to complete the proposed analytical protocol, multiple iterations of sample collection or simultaneous deployment of multiple sampling devices may be required. All samples will be contained and submitted for chemical analyses as described in Sections 6.2 and 6.3. Sample locations are described in Section 3.1 and 3.2. Sample numbering is described in Section 6.3.1.1. The proposed analytical protocol is presented in Tables 3-3, 3-4, 5-3, and 5-4.

4.6.1 SURFACE SEDIMENT SAMPLING

Surface sediment samples will be collected from the Calcasieu Estuary using a low-draft boat. These samples will be used for characterization of nature and extent of contaminants and to support risk assessment. Specific equipment that may be used to obtain samples of the shallow sediment will include a modified large Ekman® dredge (Appendix D). All sediment samples will be collected in accordance with CDM Federal's SOP 1-1, Surface Water and Sediment/Sludge Sampling (Appendix B).

4.6.2 MULTI-DEPTH SEDIMENT SAMPLING

Samples of sediment will also be collected from a boat at depth intervals of 10 to 20-cm (4 to 8-in) and 20 to 30-cm (8 to 12-in) at selected locations within the Calcasieu Estuary. These samples are to evaluate contaminant concentrations in the vertical profile in areas. Specific equipment used to obtain samples of the shallow sediment includes a piston sampler (Appendix D). All sediment samples will be collected in accordance with CDM Federal's SOP 1-1, Surface Water and Sediment/Sludge Sampling (Appendix B).

Upon sample retrieval, the sample sections will be divided and then homogenized in a decontaminated stainless steel bowl or dedicated aluminum pan. After homogenization, the sample containers will be filled. With multiple iterations of sampling at a single location, the depth of collection must be equal (i.e., preference should be given to lateral adjustments, rather than adjustment in the vertical profile). The proposed analytical protocol is identified in Tables 3-3, 3-4, 5-3 and 5-4.

4.6.3 GENERAL SEDIMENT SAMPLING PROCEDURE

Sediment sampling will be in accordance with SOP 1-1 and generally consist of the following steps.

1) Calibrate all field monitoring equipment in accordance with manufacturer's instructions and SOP 5-1 (Appendix B). Record all calibration information on the calibration form. Perform continuing calibrations at least once during the day, or more as needed.

2) Gather required equipment and navigate to the sampling site using predetermined coordinates and differential GPS unit. Note that the sediment sample collection will progress from downstream locations to upstream locations.

3) Stabilize the boat at each sample location by deploying a "spud" into the sediment on opposite corners of the boat. For safety reasons, the boat should be parallel to wind direction. An anchor should not be used because of sediment disturbance. Record the position of the actual sampling location with the GPS unit.

4) Set up the sediment sampling equipment as described in Section 5.4 of SOP 1-1 (Appendix B). The top of sediment and the sample interval to be collected will be approximate.

5) Collect samples at the predetermined depths in accordance with Section 5.4 of SOP 1.1 (Appendix B). Collect sufficient volume to fill all sample jars. Set aside an aliquot of sample for physical testing. Homogenize sample intervals. Contain, label, and handle all samples in accordance with Section 6.0 and SOP 2-5.

6) Log the sediment in accordance with SOP 3-5 (Appendix B). Measure and record physical parameters including stiffness (with a penetrometer) and oxidation/reduction potential on the borehole log form (Appendix E).

7) Rinse any extra sample volume and the sampler in the river or bayou at point of collection. Scrape off excess sediment, as needed. Decontaminate the sampling equipment in accordance with SOP 4-5 (Appendix B). Retain all decontamination and rinse water for future disposal.

4.7 SOIL SAMPLING

Soil samples will be collected from 13 CDFs located in the Calcasieu Estuary. Surface soil samples will be collected from 0 to 15-cm (0 to 6-in) deep. Soil sampling procedures will follow CDM Federal's SOP 1-3, Surface Soil Sampling (Appendix B). Soil samples will be collected with the use of Teflon-lined hand tools or stainless steel spoons. The lithology of the soil at each CDF will be described and recorded in accordance with CDM Federal's SOP 3-5, Lithologic Logging (Appendix B). Field forms are included in Appendix E. All samples will be contained and submitted for chemical analysis as described in Sections 6.2 and 6.3. Sample locations are described in Section 3.4. Sample numbering is described in Section 6.3.1.1. The proposed analytical protocol is presented in Tables 3-3, 3-4, 5-3, and 5-4.

Surface soil sampling will be in accordance with SOP 1-3 and generally consist of the following steps:

1) Calibrate all field monitoring equipment in accordance with manufacturer's instructions and SOP 5-1 (Appendix B). Record all calibration information on the calibration form. Perform continuing calibrations at least once during the day, or more as needed.

2) Gather required equipment and navigate to the CDF using Table 3-6 and Figure 3-10.

3) Locate composite locations from GPS coordinates.

4) Collect soil samples and GPS coordinates. Measure depth from which the sample was collected and record in logbook in accordance with SOP 3-5 (Appendix B).

5) Composite aliquots in stainless steel bowl. Contain, label, and handle all samples in accordance with Section 6.0.

6) Log the soil sample in accordance with SOP 3-5 (Appendix B).

7) Rinse any extra sample volume and the hand tool on to the CDF. Scrape off excess soil as needed. Decontaminate the sampling equipment in accordance with SOP 4-5 (Appendix B). Retain all decontamination and rinse water for future disposal.

4.8 TISSUE SAMPLING

Tissue samples will be collected throughout the Calcasieu Estuary. Table 3-5 provides a list of the target species for this collection. All samples will be contained and submitted for chemical analyses as described in Sections 6.2 and 6.3. Areas of collection are described in Section 3.3. Sample numbering is described in Section 6.3.1.1. The proposed analytical protocol is presented in Tables 3-2, 3-3, 5-3, and 5-4.

A subcontractor will perform the collection of the biota. The subcontractor will be responsible for equipment used for collection and obtaining all necessary permits for scientific collection. Typical means of collecting many of the fish and/or invertebrate species, where electro-shocking is not an option (due to salinity), include hook and line, trolling line, handline, bait casting, trot lines, or netting. Minnows or similar bait species may be collected with legal cast nets, minnow traps, dip nets, or bait seines in accordance with the Louisiana Department of Wildlife and Fisheries. Clams rakes or similar tool will be used to collect clams for analysis.

Biota tissue sampling will consist of the following steps:

1) Gather required equipment and accompany subcontractor to locations for biota collection.

2) Record latitude/longitude with GPS unit and collect water quality measurements.

3) Record all species collected on log form, Biota Collection Log Sheet (Appendix E). Determine length and weight of fish collected and record on log sheet.

4) Wrap sample in aluminum and place in Ziploc® bag. Properly label sample in accordance with SOP 3-5 (Appendix B) and place on dry ice in sample cooler. Keep sample frozen at all times. Samples will be shipped to appropriate laboratories upon completion of biota collection for Phase II.

4.9 SEDIMENT TRIAD INVESTIGATION

Testing locations within the Calcasieu Estuary were selected to achieve broad spatial coverage and a broad distribution of sediment chemistry. Reference locations having closely matched habitats to those sampled at the site have also been identified. Sample locations are described in Section 3.3. Sample numbering is described in Section 6.3.1.1.

Collection of sediment for toxicity testing and benthic macroinvertebrate community survey will consist of the following steps outlined below. These procedures may change upon agreement with a laboratory specializing in benthic macroinvertebrate taxonomic identification.

1) Gather required equipment and navigate to the sampling site using predetermined coordinates and differential GPS unit. Note that the sediment sample collection will progress from downstream locations to upstream locations.

2) Stabilize the boat at each sample location by deploying a “spud” into the sediment on opposite corners of the boat. For safety reasons, the boat should be parallel to wind direction. An anchor should not be used because of sediment disturbance. Monitor the position of the actual sampling location with the GPS unit.

3) Set up the sediment sampling equipment as described in Section 5.4 of SOP 1-1 (Appendix B). The top of sediment and the sample interval will be approximate.

4) Collection of sediments for characterizing the macrobenthic community will be conducted simultaneously with sediment for chemical characterization. Five replicate samples will be collected at each location. Do not mix sediment adhering to the outside of the sampler with the sample.

5) Sediments will also be collected for chemical analysis, toxicity tests, and bioaccumulation bioassays. Samples will be collected at predetermined depths in accordance with Section 5.4 of SOP 1-1 (Appendix B). Contain, label, and handle all samples in accordance with Section 6.0.

6) Log the sediment in accordance with SOP 3-5 (Appendix B).

7) Rinse any extra sample volume and the sampler in the river or bayou. Scrape off excess sediment, as needed. Decontaminate the sampling equipment in accordance with SOP 4-5 (Appendix B). Retain all decontamination and rinse water for future disposal.

4.10 SURFACE WATER SAMPLING

Surface water samples will be collected throughout the estuary and reference sites. They will be collected prior to sediment samples starting down gradient and preceding up gradient to avoid the collection of turbid samples and the possibility of cross-contamination.

Surface water sampling procedures will follow CDM Federal’s SOP 1-1, Surface Water and

Sediment/Sludge Sampling (Appendix B). Physical parameters will be measured at the surface, then in two-foot increments throughout the water column at each sample location. Because of the sample volume necessary to complete the proposed analytical protocol, multiple iterations of sample collection, simultaneous deployment of multiple sampling devices, or a peristaltic pump may be required. The samples for metals analyses may require filtered and unfiltered aliquots for both dissolved and total metals concentrations respectively. All samples will be contained and submitted for chemical analyses as described in Sections 6.2 and 6.3 . The number of samples and sample location are described in Section 3.1. Sample numbering is described in Section 6.3.1.1. The proposed analytical protocol is presented in Tables 3-2.

Samples of surface water will be collected within the estuary and reference areas using a low-draft boat. A flat-bottom boat or a timber bridge may be required to access the sample locations in very narrow and or shallow stretches of the bayou. Specific equipment used to obtain samples of the surface water includes a horizontal Kemmerer® water sampler, a Van Dorn® bottle, and/or a peristaltic pump with dedicated tubing (Appendix C).

Surface water sampling will consist of the following steps:

1) Calibrate all field monitoring equipment in accordance with manufacturer's instructions and SOP 5-1 (Appendix B). Record all calibration information on the calibration form. Perform continuing calibrations at least once during the day, and as needed.

2) Gather required equipment and navigate to the site sampling using predetermined coordinates and the differential GPS unit. Note that surface water sample collection should progress from downstream locations to upstream locations. In addition, surface water sampling will be conducted prior to sediment sampling at each location.

3) Stabilize the boat at each location using a "spud" on opposite corners of the boat. For safety reasons, the boat should be parallel to wind direction. No anchor should be used because of the potential for stirring up sediment. Record the actual position of the sample location with the GPS unit.

4) Measure the surface water column thickness (depth to sediment using a calibrated, weighted probe) from a downstream location (i.e., back of boat if sampling from the front or sides). Record depth of the water column.

5) Set up peristaltic pump with clean tubing as described in Section 5.3.2 of SOP 1-1 (Appendix B). The length of drop tubing from the pump should be equal to the depth of the water column so the bottom of the water column can be evaluated. The bottom sediments must not be disturbed.

6) Adequately mark the drop tubing for depth control. The tubing may be attached to an aluminum telescoping pole using inert nylon wire ties to maximize depth measurement accuracy and minimize current deflections. The tubing inlet should be at least 15 cm (6 in) away from the pole to minimize potential chemical impacts from the pole.

7) Collect aliquots of surface water at 2 foot increments from the surface to the total depth of the water column for physical testing. Allow the pump to purge for at least two minutes prior to collecting a sample for physical testing. A flow through cell, 500-ml sample jar, or equivalent container may be used to collect and contain the sample. It is not necessary to use clean tubing or clean sample jars for these physical tests.

8) Measure and record physical parameters including pH, Eh, temperature, conductivity, salinity, DO, and turbidity for each sample interval on the well purging field form (Appendix D).

9) Do not disrupt surface sediment at the bottom sampling depths.

10) Collect samples at the predetermined depth in accordance with Sections 5.2 and 5.3 of SOP 1.1 (Appendix B) for analytical testing using the Kemmerer® or Van Dorn® horizontal bottle sampler or peristaltic pump. Contain, label, and handle all samples in accordance with Section 6.0. Dedicated tubing must be used if the peristaltic pump is used to collect surface water samples for offsite analyses.

4.11 FIELD INSTRUMENT PROCEDURES

Several instruments will be used in the field by CDM Federal and/or subcontractor personnel. A PID will be used to monitor the breathing zone for health and safety requirements, as well as VOC screening of samples. Other field equipment may include instruments to measure conventional variables such as pH, Eh, conductivity, temperature, DO, salinity, and turbidity of surface water and/or sediment. All instruments will be calibrated and operated in accordance with manufacturers' instructions. The following subsections briefly describe the instruments and their general use. While the following procedures are applicable to most instruments, field personnel should consult the manufacturers' instructions manual for each specific instruments prior to use.

4.11.1 FIELD MEASUREMENTS

A Horiba U22 water quality meter (or equivalent) may be used to collect conductivity, pH, temperature, turbidity, Eh, salinity, and dissolved oxygen measurements.

Conductivity measures the ability of material dissolved in water to conduct electricity. The conductivity meter should measure in the range of 0 to 20,000 micromhos per cm (µmhos/cm) with an accuracy of ± 2 % at 25°C. As an indication of the water's acidity or alkalinity, pH measures the activity of hydrogen ions in the water. Meter values for the pH run on a scale from 0 to 14 with an accuracy of ± 0.05 at 25°C. Temperature measures the intrinsic heat of an object or substance and the meter should have a range of 0 to 50 °C with an accuracy of ± 1.0 °C.

Turbidity, cloudiness in water, is caused by suspended solid mater which scatter light passing through the water. Measurement of turbidity is indirect, in that, the solids are not measured; instead, their interaction with light is measured. Results are measured in nephelometric turbidity units (NTU). The meter should have a range of 0 to 800 NTU with an accuracy of ± 5% at 25°C.

The Eh, salinity, and dissolved oxygen parameters are screening level data that will be used to evaluate stratification of surface water in the Calcasieu Estuary, Calcasieu Lake and SNWR. The Eh measures the oxidation or reduction strength of a solution. A positive value for the Eh indicates that the environment is oxidizing, whereas a negative value indicates that the environment is chemically reducing. The range for the Eh meter should be ± 1999 millivolts (mV) with an accuracy of ± 15 mV at 25°C. Salinity is the total of all salts dissolved in water and the meter should have values ranging from 0 to 4% with an accuracy of ± 0.3% at 25°C. DO measures the amount of gaseous oxygen dissolved in water. The meter should have a range 0 to 19.99 milligram per liter (mg/L) with an accuracy of ± 0.3% at 25°C.

4.11.2 PHOTO-IONIZATION DETECTOR

The PID measures the concentration of gaseous organic compounds through the photo-ionization of organic vapors. The primary purpose of the measurement is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if PPE such as a respirator or a supplied air device is necessary for field personnel. In addition to health and safety monitoring, organic vapor measurements can be used in conjunction with sampling activities where measurements are useful for establishing approximate contaminant levels or ranges.

4.12 EQUIPMENT DECONTAMINATION

All reusable equipment used to collect, handle, or measure samples will be decontaminated in accordance with CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites (Appendix B). All equipment must be properly decontaminated before contact with any sample. Decontamination of equipment will occur either at the stationary decontamination area or at portable decontamination areas setup near specific sampling locations. All deviations from the decontamination procedures will be recorded in the applicable field logbook.

4.13 INVESTIGATION-DERIVED WASTE TRACKING

The CDM Federal Task Manager will ensure that all IDW is handled in accordance with CDM Federal SOP 2-6, Guide to Handling of Investigation-Derived Waste, (Appendix B). An IDW staging area is established at the field office. IDW will consist of aqueous and solid waste. The aqueous waste stream will consist primarily of decontamination and rinse water; solid IDW consists of sediment from the estuary. The aqueous wastes will be stored in appropriate containers, on appropriate containment, in a secured area, and preferably covered with a tarp.

Sediment IDW will be returned to the surface water at the point of collection.

IDW samples will be collected from waste containers for analysis. The samples will be composites, collected as grab samples from each drum after the waste has been mixed then combined. PPE will be decontaminated and disposed as municipal waste. The results will be compared to TCLP regulatory levels.

If the waste sample analyses are less than the regulatory levels established for TCLP, it will be disposed of at a local wastewater treatment plant. Because Work Plan Revision No. 5 assumes only non-hazardous IDW will be generated for disposal, if any of the IDW waste samples exceed the TCLP limits, handling and disposal of hazardous waste will require a cost and schedule modification. CDM Federal will be responsible for characterizing and arranging for disposal of IDW. EPA will sign the appropriate transport/disposal documentation (i.e., the manifest or bill of lading for hazardous and nonhazardous waste, respectively).

To prevent the inappropriate disposal of this waste, a tracking system will be implemented to document the amount of contamination present in the waste, so that proper disposal methods can be used. The waste tracking will be performed by the CDM Federal Task Manager. Waste tracking includes: segregation by waste type, container labeling, container movement, container storage, and disposal. An IDW tracking form is included in Appendix E.

5.0 PROJECT MANAGEMENT

This QAPP (Part II of the SAP) supports the Calcasieu Estuary RI/FS Phase II sampling program. It was prepared in accordance with EPA QA/R-5 guidance for preparing QAPPs (EPA 1998). This section covers project management activities including the project organization, background and purpose, project description, quality objectives and criteria, special training, documentation and records.

5.1 PROJECT ORGANIZATION

Organization and responsibilities specific to this investigation are discussed in this section and an organization chart is provided as Figure 5-1. CDM Federal will provide the necessary technical staff to perform sampling and reporting aspects of the project. CDM Federal will also procure subcontractors to provide sampling and analytical support, when necessary. Laboratory services will be provided by a CDM Federal subcontract laboratory for chemical analysis, a whole sediment toxicity testing laboratory, benthic studies lab, a microtox® and porewater toxocity lab, the EPA Regional (Region VI) Laboratory and the EPA Region VI CLP laboratory. Other subcontractor support (e.g., boat operators) have not been confirmed. The work is being performed for EPA who has oversight responsibilities.

5.1.1 MANAGEMENT ORGANIZATION

CDM Federal is a RAC contractor to EPA. EPA management is described in Section 5.1.3. The CDM Federal Project Manager is Mr. Mitchell S. Goldberg. The Task Manager for the RI portion is Mr. Clint Werden. Mr. Scott Stone, acting as Site Manager, will be responsible for directing all field sampling activities. Ms. RoseMary Gustin is the Region VIII RAC QA Manager and is responsible for the overall QA activities associated with this project. Mr. George DeLullo is the RAC Regional QA Coordinator who will oversee project designated QA activities and Ms. Krista Lippoldt is the Denver QA Coordinator who will oversee day-to-day

QA activities for this project.

Mr. Goldberg, as Project Manager, is responsible for the overall management and coordination of the following activities:

- Maintaining communications with EPA regarding the status of this project;
- Preparing weekly and monthly status reports;
- Supervising production and review of deliverables;
- Providing oversight of the subcontractors;
- Coordinating with the laboratory regarding the analytical, data validation, and QA issues related to sample analysis;
- Reviewing analytical results and deliverables from subcontractors;
- Tracking work progress against planned budgets and schedules;
- Incorporating and informing EPA of changes in the Work Plan, SAP, HASP, and/or other project documents;
- Notifying the CDM Federal Region VIII RAC QA Manager, RAC Regional QA Coordinator, or Denver QA Coordinator immediately of significant problems affecting the quality of data or the ability to meet project objectives;
- Scheduling personnel and material resources;
- Procuring subcontractors to provide sampling and analytical support;
- Implementing field aspects of the investigation, including this SAP and other project documents;
- Implementing the QC measures specified in CDM Federal's QAPP (CDM Federal 1996a) for this contract, Quality Management Plan (QMP) (CDM Federal 1996b) for this contract, this QAPP, and other project documents;

- C Implementing corrective actions resulting from staff observations, QA/QC surveillances, and/or QA audits;
- C Providing oversight of data management; and
- C Providing oversight of report preparation.

Mr. Stone as Site Manager is responsible for the following:

- C Organizing and conducting a field planning meeting;
- C Coordinating and overseeing the efforts of the field sampling team and subcontractors providing sampling and analytical support;
- C Scheduling and conducting field work;
- C Notifying the subcontract analytical laboratories of scheduled sample shipments and coordinating work activities;
- C Gathering sampling equipment and field logbooks and confirming required sample bottles and preservatives;
- C Overseeing proper chain-of-custody and sample shipment to the analytical laboratory during sampling events;
- C Ensuring that sampling is conducted in accordance with procedures detailed in this SAP and that the quantity and location of all samples meet the requirements of the SAP; and
- C Identifying problems at the field team level, resolving difficulties in consultation with the QA staff, implementing and documenting corrective action procedures at the field team level, and providing communication between the field teams and CDM Federal management.

The roles and responsibilities of other field team members will be to assist the Task Managers with sampling activities, sample handling, and overall documentation.

5.1.2 QUALITY ASSURANCE ORGANIZATION

The QA program is implemented by CDM Federal*s Region VIII RAC QA Manager, Ms. Gustin. Ms. Gustin is independent of the technical staff and reports directly to the President of CDM Federal on QA matters. The QA Manager has the authority to objectively review projects and identify problems, and the authority to use corporate resources, as necessary, to resolve any quality-related problems.

The Denver QA Coordinator for this project, Ms. Lippoldt, and the RAC Regional QA Coordinator, Mr. DeLullo, report to Ms. Gustin on QA matters. Under Ms. Gustin*s oversight, they are responsible for the following:

- Reviewing and approving the project-specific plans;
- Directing the overall project QA program;
- Maintaining QA oversight of the project;
- Reviewing QA sections in project reports, as applicable;
- Reviewing QA/QC procedures applicable to this project;
- Auditing selected activities of this project performed by CDM Federal and subcontractors, as necessary;
- Initiating, reviewing, and following-up on response actions, as necessary;
- Maintaining awareness of active projects and their QA/QC needs;
- Consulting with the Region VIII RAC QA Manager, as needed, on appropriate QA/QC measures and corrective actions;

- Conducting internal system audits to check on the use of appropriate QA/QC measures, if applicable;

- Arranging performance audits of measurement activities, as necessary; and

- Providing monthly written reports on QA/QC activity to the Region VIII RAC QA Manager.

5.1.3 EPA MANAGEMENT

The EPA Region VIII Contracting Officer (CO), Mr. Anderson Hamp, will be responsible for overall contract management including funding and level of effort (LOE) budget approval and ensuring contractual obligations are met. Day-to-day management will be performed by EPA Region VI staff.

The EPA Region VI Project Officer (PO), Mr. Tom Reilly, will be responsible for:

- Tracking Work Assignment budgets;

- Reviewing Work Plans;

- Providing incremental funding; and

- Maintaining communication with the WAM and CDM Federal contract personnel.

The EPA Region VI Work Assignment Manager (WAM), Mr. John Meyer, is CDM Federal's primary contact for coordinating work at the site. He will be responsible for:

- Reviewing all project deliverables prepared by CDM Federal;

- Maintaining communications with CDM Federal Project Manager regarding project status;

- C Reviewing monthly status reports;
- C Providing oversight of field efforts;
- C Facilitating and maintaining communication with the stakeholders and others, where applicable;
- C Providing technical guidance to CDM Federal;
- C Tracking work progress against planned budgets and schedules;
- C Scheduling EPA personnel and material resources; and
- C Providing oversight of EPA personnel responsible for project tasks.

5.1.4 REPORT ORGANIZATION

This QAPP information is organized in accordance with EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, EPA QA/R-5, External Review Final, October 1998 (EPA 1998). Section 5.0 presents project management and introductory information. Section 6.0 provides guidance for measurement and data acquisition. Section 7.0 details assessment and oversight aspects of the project, and Section 8.0 describes data validation and usability issues. References for the entire SAP are listed in Section 9.0.

5.2 BACKGROUND AND PURPOSE

Site background information for the Calcasieu Estuary is provided in Section 2.0 of this SAP. The purpose and objectives of the RI/FS are discussed in Section 1.1 of this SAP. The purpose of the following QAPP information is to provide guidance to ensure that all environmentally-related data collection procedures and measurements are scientifically sound and of known, acceptable, and documented quality and conducted in accordance with the requirements of the project.

5.3 PROJECT DESCRIPTION

The QAPP addresses field work performed during Phase II sampling for the Calcasieu Estuary. Sediment, surface water, soil, and biota will be sampled. These media will be analyzed for parameters listed in Section 5.4. Sampling activities and all associated procedures are described in detail in this SAP.

5.4 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

This section provides internal means for control and review so that environmentally-related measurements and data collected by CDM Federal are of known quality. The subsections below describe the DQOs and data measurement objectives.

5.4.1 DATA QUALITY OBJECTIVES

The DQO process is a series of planning steps based on the scientific method that are designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for the intended purpose. The EPA has issued guidelines to help data users develop site-specific DQOs (EPA 1994c). The DQO process is intended to:

- Clarify the study objective;
- Define the most appropriate type of data to collect;

- Determine the most appropriate conditions from which to collect the data; and

- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the design.

The goal of the DQO process is to "help assure that data of sufficient quality are obtained to support remedial response decisions, reduce overall costs of data sampling and analysis activities, and accelerate project planning and implementation."

The DQO process specifies project decisions, the data quality required to support those decisions, specific data types needed, data collection requirements, and analytical techniques necessary to generate the specified data quality. The process also ensures that the resources required to generate the data are justified. The DQO process consists of seven steps of which the output from each step influences the choices that will be made later in the process. These steps include:

Step 1: State the problem;

Step 2: Identify the decision;

Step 3: Identify the inputs to the decision;

Step 4: Define the study boundaries;

Step 5: Develop a decision rule;

Step 6: Specify tolerable limits on decision errors; and

Step 7: Optimize the design.

During the first six steps of the process, the planning team develops decision performance criteria (i.e., DQOs) that will be used to develop the data collection design. The final step of the process involves optimizing the data collection design based on the DQOs. A brief discussion of these steps and their application to this project is provided below.

5.4.1.1 Step 1: State the Problem

The purpose of this step is to describe the problem to be studied so that the focus of the study will be unambiguous. The Calcasieu Estuary consists of a tidally influenced, humid subtropical woodland and wetland systems that both historically and currently has received discharges from point and non-point sources. The Calcasieu Estuary supports commerce, commercial fishing, and recreation for several urban areas, namely Lake Charles, Westlake, and Sulphur. Chemical manufacturing and petroleum refining activities have been present in the estuary for 80 years, since the discovery of local oil deposits.

Organic and inorganic contaminants have been documented in the sediment and surface water that suggest risk to human health and the environment. A sampling and analysis program is proposed to: (1) characterize the nature and spatial extent of organic and inorganic chemical contamination in sediment, sediment porewater, benthos, biota, surface water, and soils (2) support evaluation of human health and ecological risk assessments, and (3) support feasibility study data needs.

The planning team includes Mr. John Meyer (RPM) and Mr. Jon Rauscher (Toxicologist) of the EPA (primary decision makers), Mr. Duane Wilson of the LDEQ, Mr. V. Dan Wall and Mr. Paul Conzelmann of USFWS, Mr. Ron Gouguet of NOAA, and Mr. Mitchell Goldberg and Mr. Scott Stone of CDM Federal. Resources available for this study include CDM Federal technical staff and subcontractor support staff. The budget and scope details have been updated in Work Plan Revisions No. 1 through 5, (dated September 1999 through September 2000).

5.4.1.2 Step 2: Identify the Decision

The Phase II investigation is designed to address two independent goals; the delineation of impacted areas identified in Phase I, and collect data to support a multiple line, weight-of-evidence Triad approach based baseline ecological risk assessment (BERA). This step identifies what questions the Phase II study will attempt to resolve. The principal study questions are divided into the two primary goals and include the following:

Sediment

- Were all Phase I analytical requirements met?
- Did Phase I delineate (vertically or horizontally) contaminant extent for all areas impacted above screening levels?
- Did Phase I PCB screening data exceed screening levels, indicating the need for further contaminant characterization?
- Do highly impacted sediment areas exceed TCLP limits?
- Are the Calcasieu Estuary sediments [chemistry] likely to be toxic to sediment dwelling organisms?
- Are Calcasieu Estuary sediments toxic to benthic invertebrates?
- Are Calcasieu Estuary sediments toxic to bacteria?
- Do the published SQGs correctly predict site sediment toxicity?

Sediment Porewater

- Is site sediment porewater [chemistry] likely to be toxic to sediment dwelling organisms?
- Is the porewater toxic to fish?
- Is the porewater toxic to algae?

- Is the porewater toxic to benthos?
- What is the effect of site sediment quality on survival, growth, behavior, or reproduction of aquatic organisms?

Benthos

- Is the benthic community altered?

Biota/Tissue

- Do estuarine conditions support a healthy and diverse aquatic community?
- Are the levels of contaminants in benthos sufficient to adversely affect fish or wildlife?
- Do aquatic, wetland and terrestrial habitats support healthy, diverse and self-sustaining populations of aquatic dependent avian and mammalian species?

Surface water

- Did Phase I surface water results yield definitive occurrence trends?
- Are surface waters toxic to aquatic organisms?

Confined Disposal Facilities (CDFs) Soil

- Do dredged sediments stored in the CDFs pose a leaching risk to the estuary?
- Do dredged sediments stored in the CDFs pose a sediment migration (run-off) risk to the estuary?

5.4.1.3 <u>Step 3: Identify the Inputs to the Decision</u>

The purpose of this step is to identify the information that is needed and the measurements that need to be taken to resolve the decision statement. Table 5-1 identifies the proposed steps to answer the above questions.

- Delineate the vertical and lateral extent of COPCs present above screening levels;
- Collect data to evaluate remedial options (TCLP samples);
- Sample select sample locations for PCB congeners to characterize PCB impacted areas;
- Re-sample locations which had elevated SVOC detection limit problems in Phase I;
- Verify and characterize surface water copper and mercury detections noted in Phase I;
- Determine the chronic and acute sediment effects on survival of *Hyalella azteca*. Collect data from sediments of high, median, and low levels of contamination;
- Determine the potential effects of the sediment on the microbial community (Microtox® tests);
- Perform sediment chemical testing on a broad spatial and concentration distribution to support logistic regression modeling of sediment chemistry to toxicity.
- Conduct sediment porewater chemical testing on a broad spatial and concentration distribution to support logistic regression modeling of sediment chemistry to toxicity.
- Conduct porewater toxicity testing to determine the potential chronic effects of sediments on receptors;

- Correlated contaminants in porewater with toxicity and bioaccumulation results;

- Determine macroinvertebrate abundance, community composition and ecological function;

- Analyze tissue for COPCs to evaluate ecological assessment endpoints and human health risks;

5.4.1.4 Step 4: Define the Boundaries of the Study

This step defines the spatial and temporal boundaries of the study. The horizontal spatial boundaries of the study are provided in Figures 1-2, 3-1, 3-2, 3-3, 3-4, 3-5, 3-6 and 3-10. The vertical spatial boundaries are from the air/surface water interface to the base of the sediment in the Estuary. This study focuses on current conditions from the evaluation of the Phase I RI data and to a lesser degree historical data. Therefore, temporal boundaries include the time frame from when potential source activities began (80 years ago) to the time of the current study (1999-2000). The data used for decision-making, however, will be from the most recent sampling event (December 1999 through March 2000), although the existing contaminants may have been deposited at any time since the beginning of potential source activities. The data populations needed for decision-making for this study include the chemical concentrations (including both detected and non-detected values) for all the media sampled and analyzed. Constraints that could potentially interfere with data collection are unaccessible sampling locations. Alternative locations will be selected if proposed sample locations are unaccessible.

5.4.1.5 Step 5: Develop a Decision Rule

The purpose of this step is to define the parameters of interest, specify the action levels, and integrate previous DQO outputs into a single statement that describes a logical basis for choosing among alternative actions. The parameters of interest are the concentrations and locations of constituents identified in the separate media that pose potential significant adverse risk. Measured concentrations are the true values of the constituents at a specific location and may be used on an individual (e.g., Benzo(a)pyrene) or cumulative compound (e.g., total polycyclic aromatic hydrocarbons) basis. The screening levels include sediment ERMs, wildlife benchmark criteria and human health (fish and shellfish consumption) PRGs as inputs. Table 5-2 summarizes the screening values for human health fish and shellfish consumption, ecological sediment ERMs, and wildlife benchmark values. Analytical quantitation limits are provided on Table 5-2, for comparison.

5.4.1.6 **Step 6: Specify Tolerable Limits on Decision Errors**

Decision maker's tolerable limits on decision errors, which are used to establish performance goals for the data collection design, are specified in this step. Decision makers are interested in knowing the true value of the constituent concentrations. Since analytical data can only estimate these values, decisions that are based on measurement data could be in error (decision error). There are two reasons why the decision maker may not know the true value of the constituent concentration, these are:

(1) Concentrations may vary over time and space. Limited sampling may miss some features of this natural variation because it is usually impossible or impractical to measure every point of a population. *Sampling design error* occurs when the sampling design is unable to capture the complete extent of natural variability that exists in the true state of the environment.

(2) Analytical methods and instruments are never absolutely perfect, hence a measurement can only estimate the true value of an environmental sample. *Measurement error* refers to a combination of random and systematic errors that inevitably arise during the various steps to the measurement process.

The combination of sampling design and measurement error is the total study error. Since it is impossible to completely eliminate total study error, basing decisions on sample concentrations may lead to a decision error. The probability of decision error is controlled by adopting a scientific approach in which the data are used to select between one condition (the null hypothesis) and another (the alternative hypothesis). The null hypothesis is presumed to be true in the absence of evidence to the contrary. For this project the null hypothesis is that the true values of the constituents are below the action levels. The alternative hypothesis is that the true values of the constituents are above the action levels.

An example of decision errors and tolerable limits are presented in graphical form in Figure 5-2 (An electronic figure is to be provided at a later time). A false positive or "Type I" decision error refers to the type of error made when the null hypothesis is rejected when it is true and a false negative or "Type II" decision error refers to the type of error made when the null hypothesis is accepted when it is false. For this project, a Type I decision error would result in deciding that the site was contaminated above action levels ("dirty") when it is not and a Type II decision error would result in deciding that the site was not contaminated above action levels ("clean") when it is. For example, if the action level for a constituent is 2,300 milligrams per kilogram (mg/kg), the reported concentration is 2,200 mg/kg, and the true value is 2,400 mg/kg, a Type II error could easily be made by not applying any decision error limits. For this project, a Type II error is less acceptable (worse case) than a Type I error because a Type II error could result in ecological and/or human harm whereas, a Type I error could result in spending additional funding for further investigating a "clean" site.

The closer the reported concentration is to the action level, the higher the probability that an incorrect decision will be made and, therefore, there is a "gray region" surrounding the action level. Remediation goals should have a confidence and precision in fair agreement with chemical concentrations used in the risk assessment.

5.4.1.7 <u>Step 7: Optimize the Design for Obtaining Data</u>

This step identifies a resource-efficient data collection design for generating data that are expected to satisfy the DQOs. The data collection design or sampling program is described in detail in

Section 3.0. Various methods were used to design each of the four Phase II sample collection components. Design detail is provided in Section 3.

5.4.2 DATA MEASUREMENT OBJECTIVES

Biota, soil, sediment and aqueous samples will be analyzed for total TAL metals, TCL SVOCs, TCL pesticides, Total TCL PCBs, PCB congeners, and Dioxin/Furans. Twenty percent of the biota samples will be analyzed for PCB congeners and Dioxin/Furans to provide limited random sampling. Sediment samples will also be analyzed for AVS/SEM and utilized for toxicity testing, bioaccumulation bioassays, and benthic community surveys. Sediment samples may also be analyzed for several other field measurements, as described in Section 4.0.

Every reasonable attempt will be made to obtain a complete set of usable field measurements and analytical data. If a measurement cannot be obtained or is unusable for any reason, the effect of the missing data will be evaluated by the CDM Federal Project Manager and CDM Federal QA staff. This evaluation will be reported to EPA with a proposed corrective action.

5.4.2.1 Quality Assurance Guidance

The field QA program has been designed in accordance with CDM Federal*s RAC VIII QAPP (CDM Federal 1996a), the QMP for this contract (CDM Federal 1996b), EPA*s Guidance for the DQOs Process (EPA 1994c), and the EPA*s Requirements for Quality Assurance Project Plans for Environmental Data Operations, QA/R-5 (EPA 1998).

5.4.2.2 Precision, Accuracy, Representativeness, Completeness, and Comparability Criteria

Precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters are indicators of data quality. PARCC goals are established for the site characterization to aid in assessing data quality. All data evaluations will be in accordance with the criteria presented in Table 5-3. The following paragraphs define these PARCC parameters in conjunction with this project.

Precision. The precision of a measurement is an expression of mutual agreement among individual measurements of the same property taken under prescribed similar conditions. Precision is quantitative and most often expressed in terms of relative percent difference (RPD). Precision of the laboratory analyses will be assessed by comparing original and duplicate results, where applicable. The RPD will be calculated for each pair of applicable duplicate analyses using the following equation:

$$\textit{Relative Percent Difference} = |S - D| / ((S + D)/2) \times 100$$

Where S = First sample value (original value); and

D = Second sample value (duplicate value)

Precision of reported results is a function of inherent field-related variability and/or laboratory analytical variability depending on the type of QC sample. Data may be evaluated for precision using the following types of samples (in order of priority): field duplicates, laboratory duplicates, laboratory control sample/laboratory control sample duplicates (LCS/LCSDs), or MS/MSDs, whichever are analyzed and specified by Table 5-3.

The acceptable RPD limits for duplicate measurements are listed in Table 5-3 and are in accordance with the laboratory-specific limits, methodology, EPA Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review (EPA 1994a), or EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 1994b), whichever are applicable.

Accuracy. Accuracy is the degree of agreement of a measurement with an accepted reference or true value and is a measure of the bias in a system. Accuracy is quantitative and usually expressed as the percent recovery (%R) of a sample result. %R is calculated as follows:

$$\textit{Percent Recovery} = SSR - SR/SA \times 100$$

Where: SSR = Spiked Sample Result

SR = Sample Result

SA = Spike Added

Ideally, it is desirable that the reported concentration equals the actual concentration present in the sample. Data may be evaluated for accuracy using (in order of priority) either LCS/LCSDs, MS/MSDs, and/or surrogates, as specified by Table 5-3. The acceptable %R limits are presented in Table 5-3 and are in accordance with the laboratory-specific limits, methodology, EPA National Functional Guidelines for Inorganic Data Review (EPA 1994a), or EPA National Functional Guidelines for Organic Data Review (EPA 1994b), whichever are applicable.

Representativeness. Representativeness expresses the degree to which sample data accurately and precisely represent:

- the characteristic being measured,
- parameter variations at a sampling point, and/or
- an environmental condition.

Representativeness is a qualitative and quantitative parameter that is most concerned with the proper sampling design and the absence of cross-contamination of samples. Acceptable representativeness will be achieved through (a) careful, informed selection of sampling sites, (b) selection of testing parameters and methods that adequately define and characterize the extent of possible contamination and meet the required parameter reporting limits, (c) proper gathering and handling of samples to avoid interferences and prevent contamination and loss, and (d) collection of a sufficient number of samples to allow characterization. The representativeness will be assessed qualitatively by reviewing the sampling and analytical procedures and quantitatively by reviewing the blank samples. If an analyte is detected in a method, preparation, or rinsate blank, any associated positive result less than five times (10 times for common laboratory contaminants) may be considered a false positive as specified in Table 5-3. Holding times will also be evaluated to determine if analytical results may be representative of sample concentrations.

Completeness. Completeness is a measure of the amount of usable data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Usability will be determined by evaluation of the PARCC parameters excluding completeness. Those data that are validated or evaluated and are not considered estimated or are qualified as estimated or nondetect are considered usable. Rejected data are not considered usable. A completeness goal of 90 percent is projected. If this goal is not acheived, the effect of not meeting this goal will be discussed by the CDM Federal Project Manager and the EPA WAM. Completeness is calculated using the following equation:

$$\textit{Percent Completeness} = (DO/DP) \times 100$$

Where: DO = Data Obtained and usable.

DP = Data Planned to be obtained.

Comparability. Comparability is a qualitative parameter. Consistency in the acquisition, handling, and analysis of samples is necessary for comparing results. Data developed under this investigation will be collected and analyzed using standard EPA analytical methods and QC to ensure comparability of results with other analyses performed in a similar manner.

5.4.2.3 Field Measurements

Field measurements collected during this investigation will include: water quality parameters including pH, temperature, conductivity, turbidity, DO, Eh, and salinity; sediment Eh and pH from the limited surface water sampling; and collection of soil density and Eh in shallow and cored sediments.

5.4.2.4 Laboratory Analysis

Analytical methods, reporting limits, holding times and preservatives, and QC analyses are discussed below.

Analytical Methods

All analyses and methods are listed in Tables 3-2, 3-3 and 5-4. Tables 3-2 and 3-3 present the analyses and QC summary for each media. Volume requirements are presented in Table 5-4.

Surface and subsurface sediment samples (including duplicate samples) collected under this SAP may be analyzed and/or extracted for the following:

- Total TAL metals, SW-846 Method 6010B
- TCL SVOCs, SW-846 Method 8270
- TCL Pesticides/PCBs, SW-846 Method 8080/8090
- PCB congeners, EPA Method 1668.
- Dioxins/Furans, SW-846 Method 8290

- TCLP, SW-846 Method 1311

Triad sediment samples will be utilized for the following:

- 10-day acute toxicity test using *Ampelisca abdita* using ASTM Method E1367

- 10-day acute toxicity test using *Hyalella azteca* using ASTM Method E1367

C 28-day chronic toxicity test using *Hyalella azteca* ASTM Method E1706

- Microtox® tests

- Chemical Analysis (same as surface water and sediment, with the exception of TCLP)

- AVS/SEM, SW-846 Method 1689

- Methyl mercury SW-846, Method 1631

- Porewater toxicity tests

    - Red drum embryo larval assay

    - Sea urchin fertilization and development assay

    - Macrophyte algal assay.

    - Benthic community surveys using *Estuarine and Coastal Marine waters Bioassessment and Biocriteria Technical Guidance*, 2000, U.S. Environmental Protection Agency, Office of Research and Development, Water, Washington, DC.

Biota samples (including duplicate samples) collected under this SAP may be analyzed for the following:

- Total TAL metals, SW-846 Method 6010B
- TCL SVOCs, SW-846 Method 8270
- TCL pesticides/PCBs, SW-846 Method 8080/8090

Twenty percent of biota samples will be analyzed for the following:

- PCB congeners using EPA Method 1668.
- Dioxins/furans using SW-846 Method 8290;

Aqueous samples collected under this SAP will be analyzed for all of the following:

- Total TAL metals, SW-846 Method 6010B
- TCL SVOCs, SW-846 Method 8270
- TCL pesticides/PCBs, SW-846 Method 8080/8090

Laboratories

CDM Subcontract lab, EPA Regional (Region VI), EPA Region VI CLP are the laboratories responsible for chemical analyses of the samples:

CDM Subcontract Laboratory
Attention: Sample Custodian
To Be Determined by CDM

EPA Regional Laboratory
EPA region VI
Attention: Sample Custodian
10625 Fallstone Road
Houston, Texas 77099-4303
(281) 983-2100
(281) 983-2248

Contract Laboratory Program
EPA Region VI
Attention: Sample Custodian
To Be Determined by EPA

Additional laboratories will be required to perform sediment toxicity testing, porewater extraction/analysis, benthic studies and invertebrate testing. Laboratory selection is in progress, possible laboratories are:

Whole Sediment Toxicity testing:

Columbia Environmental Research Center
4200 New Haven Road
Columbia, Missouri 65201
Attention: Sample Custodian

Benthic Studies:

Texas A&M University - Corpus Christi
6300 Ocean Dr.
Center for Coastal Studies
Corpus Christi, Texas 78412
Attention: Sample Custodian
Phone: 361-825-2736

Fax: 361-825-2770

MicroTox® and Porewater testing:

University of Texas at Austin
Marine Science Institute
750 Channelview Dr.
Port Aransas, Texas 78373
Attention: Sample Custodian
Phone: 361-749-6779
Fax: 361-749-6777

Reporting Limits

The reporting limits provided in Table 5-3 are the minimum levels that the laboratory will report analytical results without a qualifier when an analyte is detected. The laboratory can typically detect analytes at concentrations of up to an order of magnitude lower than the reporting limits; in this case, when a positive detection is less than the reporting limit, the value may be reported and qualified as an estimated concentration. To minimize the affects of interferences, the laboratory may modify the extraction and/or analytical methods and/or readjust the instruments. Any modifications will be documented by the laboratory and reported in the RI Report.

Holding Times and Preservatives

Holding times are storage times allowed between sample collection and sample extraction or analysis (depending on whether the holding time is an extraction or analytical holding time) when the designated preservation and storage techniques are employed. Holding times for each analytical method are provided in Table 5-3 and preservatives for each sample aliquot are listed in Table 5-4.

Quality Control Analyses

To provide an external check of the quality of the field procedures and laboratory analyses, two types of QC samples (duplicate samples and equipment rinsate blanks) will be collected and analyzed. Trip blanks will not be collected. VOCs will not be analyzed in this investigation. Triple volume will also be collected at a rate of 5 % for MS/MSD (laboratory QC) analyses for data gap sediment samples. Triple volume will be collected at a rate of 2 % for MS/MSD for applicable sediment triad investigation samples. The aqueous blank samples will be analyzed to check for equipment decontamination (rinsate). Duplicate samples will provide a check for sampling and analytical error. The samples that will be analyzed for QC are discussed in Section 6.5.1.

In addition to the external QA/QC controls, internal QC procedures are maintained by the laboratory. Internal QC samples may include laboratory blanks (i.e., method blanks, preparation blanks), laboratory duplicates, MS/MSDs, and LCS/LCSDs, as discussed in Section 5.4.2.2.

5.5 SPECIAL TRAINING REQUIREMENTS

Special training required for this investigation will be the health and safety training, as described in the HASP (Appendix A). In addition, EPA Region 6 Regional Sample Control Coordinator, Ms. Myra Perez conducted project team training, prior to Phase I sampling, on CLP sampling and data package review (Appendix E).

5.6 DOCUMENTATION AND RECORDS

The laboratories will submit analytical data reports to CDM Federal. Each data report will contain a case narrative that briefly describes the number of samples, the analyses, and any analytical difficulties or QA/QC issues associated with the submitted samples. The data report will also include signed chain-of-custody forms, cooler receipt forms, analytical data, a QC package, and raw data. An electronic copy of the data will also be provided by the laboratories to CDM Federal. This electronic copy is detailed in the subcontract with each laboratory.

Project records, including reports, field data, analytical data, audit reports, and any other records applicable to the project will be maintained in the project file.   The official project record will be maintained in CDM Federal's Denver, Colorado office. Copies of all project documentation generated by CDM Federal will be transmitted to the EPA Region VI Administrative Record.

6.0 MEASUREMENT AND DATA ACQUISITION

This section addresses sample process design, sampling methods requirements, handling and custody, analytical methods, QC, equipment maintenance, instrument calibration, supply acceptance, non-direct measurements, and data management. CLP requirements are summarized in Appendix E.

6.1 SAMPLE PROCESS DESIGN

The goal of the field investigation is to verify and quantify the presence or absence of contamination in the sampling media and to assess ecological and human health risk. The number, types, locations, and analyses of samples are presented in Tables 3-2, 3-3, and 3-8, and Section 3.0.

6.2 SAMPLING METHODS AND REQUIREMENTS

Sampling equipment and preparation, sample containers and preservatives, and sample collection, handling, and shipment are described below.

6.2.1 SAMPLING EQUIPMENT AND PREPARATION

Sampling equipment required for the field program for environmental monitoring, sampling, health and safety monitoring, equipment and personal decontamination, and general field operations are presented in Table 4-2.

Field preparatory activities include review of SOPs, procurement of field equipment, laboratory coordination, confirmation of site access, as well as a field planning meeting attended by field personnel and QA staff. Site setup is described in Section 4.0.

6.2.2 SAMPLE CONTAINERS AND PRESERVATIVES

Sample containers and preservatives required for the solid and aqueous samples are presented in Tables 5-3 and 5-4. Preservatives will be added to the sample containers by the laboratory whenever possible. Preservatives will be onsite in the event that a sample container needs to be preserved in the field. Containers and applicable preservatives will be supplied by CDM Federal for the samples sent to the EPA Region 6, CLP, PRP laboratory, and other subcontract laboratories.

6.2.3 SAMPLE COLLECTION, HANDLING, AND SHIPMENT

Samples collected during this field program consist of sediment, surface water, tissue, soil, IDW, and QC samples. All sample collection procedures are outlined in the FSP (Part I of this SAP) and/or CDM Federal*s Technical Standard Operating Procedures Manual (CDM Federal 1999). The following SOPs (provided in Appendix B) apply to all applicable procedures unless otherwise noted in the FSP:

CDM Federal SOPs:

C SOP 1-1, Surface Water and Sediment Sludge Sampling;

C SOP 1-2, Sample Custody;

• SOP 1-3, Surface Soil Sampling

• SOP 1-4, Subsurface Soil Sampling

C SOP 1-10, Field Measurement of Organic Vapors;

C SOP 2-5, Packaging and Shipping of Environmental Samples;

C SOP 2-6, Guide to Handling of Investigation-Derived Waste;

C SOP 3-5, Lithologic Logging;

- SOP 3-6, Benthic Macroinvertebrate Survey
- SOP 4-1, Field Logbook Content and Control;
- SOP 4-2, Photographic Documentation of Field Activities (with site-specific modification);
- SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites; and
- SOP 5-1, Control of Measurement and Test Equipment.

6.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Custody and documentation for field and laboratory work are described below, followed by a discussion of corrections to documentation.

6.3.1 FIELD SAMPLE CUSTODY AND DOCUMENTATION

The information contained on the sample label and the chain-of-custody record must match. The purpose and description of the sample label and the chain-of-custody record are discussed in the following sections.

6.3.1.1 Sample Labeling and Identification for Sediment, Soil and Aqueous Samples

An alpha-numeric coding system will be used to uniquely identify each sample collected during the field investigation (as specified in SOP 1-2, Sample Custody). The following section applies to sediment sampling for chemical analysis and toxicity tests.

Sample numbers will begin with the year, site abbreviation, and phase number (e.g., “00BI2” indicates that the sample was collected in 2000, at the Bayou d’Inde during Phase 2 or “00SN2" indicates that the sample was collected in 2000, at the Sabine National Wildlife Refuge). The second character set in the sample identification for sediment will indicate the location of the sample and will include the two-digit reach number followed by the three-digit sample number (i.e., “R2020”). For soil samples, the second character set in the sample identification will include the letter C to distinguish it as a CDF sample followed by the CDF location number. (i.e., “C010”). For biota samples, the second character set in the sample identification will indicate the location of the sample and will include the letter E to distinguish it as an ecological sample followed by the station location (i.e., “E2020”). For the sediment triad investigation, the second character set in the sample identification will indicate the location of the sample and will include the letters ST to distinguish it as a sediment triad sample followed by the station location (i.e. “ST001"). The third character set represents the type and media of the sample (i.e., “XXX”). Types of samples will include the following:

N	=	Normal
D	=	Duplicate
R	=	Rinsate

Media codes will include the following:

SD	=	Sediment
SW	=	Surface Water
SS	=	Surface Soil
BW	=	Biota Whole Body
BF	=	Biota Fillet
ID	=	IDW Water

The final set of numbers (i.e., “###”) for sediment and soil samples represents the ending depth interval rounded to the nearest centimeter (e.g., the 0 to 10-cm samples will end in “010"). For tissue samples, the characters will represent the tissue group (i.e., Group 1 is “001", Group 2 is “002", etc.). The following are examples of sample identification codes:

00BI2-R2001-NSD-010

00BI2	=	2000, Bayou d'Inde, Phase 2
R2001	=	Reach Number 2, Sample Location 001
N	=	Normal (non-QC) Sample
SD	=	Sediment
010	=	Depth Interval (ending depth is 10 cm into sediment)

00BI2-C010-DSS-015

00BI2	=	2000, Bayou d'Inde, Phase 2
C010	=	CDF Facility 10
D	=	Duplicate Sample
SS	=	Soil
015	=	Depth Interval (ending depth is 15 cm into soil)

00LC2-E001-NBF-001

00LC2	=	2000, Lower Calcasieu, Phase 2
E001	=	Ecological Sample Location 001 in Lower Calcasieu
N	=	Normal (non-QC) Sample
BF	=	Biota Fillet
001	=	Sample collected from Group 1

00BI2- R2001-RSD-010

00BI2	=	2000, Bayou d’Inde, Phase 2
R2001	=	Reach Number 2, Sample location 001
R	=	Rinsate Sample
SD	=	Collected for Sediment Samples
030	=	Depth interval of original sample (ending depth is 30 cm into sediment)

Labels will be used in accordance with SOP 1-2, Sample Custody (Appendix B).

A number of samples will be submitted to EPA Region 6 CLP. Sample labeling will conform to the requirements of Region 6 CLP (Appendix E).

6.3.1.2 Chain-of-Custody Requirements

Chain-of-custody procedures will follow the requirements set forth in CDM Federal*s SOP 1-2, Sample Custody (Appendix B). The chain-of-custody record is employed as physical evidence of sample custody and control. This record system provides the means to identify, track, and monitor each individual sample from the point of collection through final data reporting.

A number of samples will be submitted to EPA Region 6 CLP. Chain-of-custody will conform to the requirements of Region 6 CLP (Appendix E).

6.3.1.3 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with SOP 2-5, Packaging and Shipping of

Environmental Samples (Appendix B) and/or the EPA Region 6 CLP requirements (Appendix E), as appropriate.

6.3.1.4 Field Logbook(s) and Records

Field logbook(s) will be maintained by the field team in accordance with SOP 4-1, Field Logbook Content and Control (Appendix B). The Site Manager is responsible for maintenance and document control of the field logbooks. Field logbook entries will be photocopied weekly and entered in the project files..

6.3.1.5 Photographs

Field teams may photograph appropriate field work activities for documentation purposes. Photographs will be documented in accordance with SOP 4-2, Photographic Documentation of Field Activities with modification. Modification to this SOP has been requested and approved and is included in Appendix B.

6.3.2 LABORATORY CUSTODY PROCEDURES AND DOCUMENTATION

Laboratory custody procedures are provided in each laboratories' QA Manual. Upon receipt at the laboratory, each sample shipment will be inspected to assess the condition of the shipping cooler and the individual samples. This inspection will include measuring the temperature of the cooler (if chilling is required) to document that the temperature of the samples is within the acceptable criteria (4 ± 2 degrees Celsius [°C]) and verifying sample integrity. The pH of the samples will be measured, if preserved with an acid or a base. The enclosed chain-of-custody records will be cross-referenced with all of the samples in the shipment. These chain-of-custody records will then be signed by laboratory personnel. Copies provided to CDM Federal will be placed in the project files. The sample custodian may continue the chain-of-custody record process by assigning a unique laboratory number to each sample on receipt. This number, if assigned, will identify the sample through all further laboratory handling. It is the laboratory*s responsibility to maintain internal logbooks and records throughout sample preparation, analysis, data reporting, and disposal.

6.3.3 CORRECTIONS TO AND DEVIATIONS FROM DOCUMENTATION

Logbook modification requirements are described in SOP 4-1, Field Logbook Content and Control (Appendix B). For the logbooks, a single strikeout initialed and dated is required for documentation changes. The correct information should be entered in close proximity to the erroneous entry. All deviations from the guiding documents will be recorded in the logbook(s). Any major deviations will be documented according to the QMP (CDM Federal 1996b).

6.4 ANALYTICAL METHODS REQUIREMENTS

The laboratory QA program and analytical methods are addressed below.

6.4.1 LABORATORY QUALITY ASSURANCE PROGRAM

Samples collected during this project will be analyzed in accordance with standard EPA and/or nationally-accepted analytical procedures. Subcontracted laboratories, EPA Region 6 Laboratory, PRP laboratory and the EPA Region 6 CLP laboratories will adhere to all applicable QC requirements established by the subcontract and applicable analytical methods.

6.4.2 METHODS

The methods to be used for chemical analysis are discussed in Section 5.4.2.4. The holding time requirements for each analytical method are provided in Table 5-3.

6.5 QUALITY CONTROL REQUIREMENTS

Field, laboratory, and internal office QC are discussed below.

6.5.1 FIELD QUALITY CONTROL SAMPLES

The following types of QC samples will be collected in the field and shipped to the appropriate subcontractor, PRP laboratory or Region 6 CLP laboratory for analysis:

- Field duplicates, and
- Equipment rinsate blanks.

These types of QC samples are discussed below.

6.5.1.1 Field Duplicates

Field duplicates for sediment samples will be collected at a single sampling location, collected identically and consecutively over a minimum period of time. This type of field duplicate measures the total system variability (field and laboratory variance), including the variability component resulting from the inherent heterogeneity of the sediment. Field duplicates will be collected at a minimum frequency of one per 10 samples per media (10 percent) (Table 3-3).

6.5.1.2 Equipment Rinsate Blanks

An equipment rinsate blank will be prepared and submitted for analysis at a minimum frequency of one per 20 samples per media (5 percent) if equipment is decontaminated between sampling locations (Table 3-3). These blanks consist of analyte-free water collected by containing the sampling equipment rinse water after equipment decontamination for sediment samples. Field equipment decontamination procedures are defined in SOP 4-5 provided in Appendix B.

6.5.2 LABORATORY QUALITY CONTROL SAMPLES

CDM Federal's subcontract laboratories, PRP laboratory and EPA Region 6 Regional and CLP laboratories will follow all laboratory QC checks, as defined in the analytical methods listed in Section 5.4.2.2 or the CLP SOW. QC samples are necessary to determine laboratory precision and accuracy and to demonstrate the absence of interferences and/or contamination. Each type of laboratory-based QC will be analyzed at a rate of 5 percent of normal samples submitted or one per batch (a batch is a group of up to 20 samples analyzed together), whichever is more frequent. Results of laboratory QC samples will be included in the laboratory data package. Laboratory QC samples may consist of method blanks, surrogates, laboratory duplicates, MS/MSDs, LCS/LCSDs, and/or performance evaluation samples whichever are applicable, and any other method-required QC samples. Each is briefly described in the following paragraphs.

Method blank samples will be analyzed to assess possible internal laboratory contamination. If contamination is found, the laboratory can quickly initiate corrective measures to eliminate the contamination.

Laboratory duplicate samples are aliquots of a single sample that are split on arrival at the laboratory or upon analysis. Results obtained for two replicates that are split in a controlled laboratory environment may be used to assess laboratory precision of the analysis.

Finally, the laboratory will conduct either and/or both MS/MSD and LCS/LCSD analyses to determine laboratory precision and accuracy.

For organic analyses of sediment, soil surface water tissue and rinsate samples, surrogates may be used to evaluate accuracy. Both normal and QC samples will be spiked with surrogate compounds, when applicable, and a %R will be calculated for each surrogate.

6.5.3 INTERNAL QUALITY CONTROL CHECKS

Internal QC checks will be conducted throughout the project to evaluate the performance of the project team during data generation. All internal QC will be conducted in accordance with applicable methodologies listed in Table 5-3.

All project deliverables will receive technical and QA reviews prior to being issued to EPA, as required. These reviews will be conducted in accordance with CDM Federal's Quality Procedure (QP) 3.2, Technical Document Review and QP 3.3, Quality Assurance Review (CDM Federal 1997a). Completed review forms will be maintained in the project and working files.

6.6 EQUIPMENT MAINTENANCE PROCEDURES

All laboratory equipment will be maintained in accordance with each laboratory*s SOPs.

6.7 INSTRUMENT CALIBRATION PROCEDURES AND FREQUENCY

Calibration of field and laboratory instruments is addressed in the following subsections.

6.7.1 FIELD INSTRUMENT AND EQUIPMENT CALIBRATION

Field instruments and equipment may be used to obtain water quality parameters including pH, temperature, conductivity, turbidity, DO, Eh, and salinity measurements; sediment Eh, sediment density and air VOC concentrations for health and safety screening purposes. Field instruments and equipment will be calibrated prior to use each day following manufacturer*s instructions. Calibration information will be recorded on calibration forms (Appendix E).

6.7.2 LABORATORY EQUIPMENT CALIBRATION

Calibration of laboratory equipment will be based on written procedures approved by laboratory management. Instruments and equipment will be initially calibrated and subsequently continuously calibrated at approved intervals, as specified by either the manufacturer or more updated requirements (e.g., methodology requirements). Calibration standards used as reference standards will be traceable to the EPA, National Institute of Standards and Technology, or another nationally-recognized reference standard source.

Records of initial calibration, continuing calibration and verification, repair, and replacement will be filed and maintained by each laboratory. Calibration records will be filed and maintained at the laboratory location where the work is performed and may be required to be included in data reporting packages.

6.8 ACCEPTANCE REQUIREMENTS FOR SUPPLIES

Prior to acceptance, all supplies and consumables will be inspected and documented to ensure that they are in satisfactory condition and free of defects.

6.9 NON-DIRECT MEASUREMENT DATA ACQUISITION REQUIREMENTS

Non-direct measurement data include information from site reconnaissances, literature searches, and interviews. The acceptance criteria for such data include a review by someone other than the author. Any measurement data included in information obtained from the above-referenced sources will determine further action at the Calcasieu Estuary only to the extent that those data can be verified.

6.10 DATA MANAGEMENT

Sample results and QC data will be delivered to CDM Federal as an electronic data deliverable (EDD) in addition to a hard-copied data package. Electronic copies of all project deliverables, including graphics, are maintained by project number. Electronic files are routinely backed up and archived. The Final SAP and RI Report will be submitted to EPA on 3.5-inch diskettes or CD-Rom in WordPerfect 6.0/6.1 and MS Access 97 or MS Excel 97 (and any other applicable software such as AutoCADD, ARCView, or ARCInfo), if requested. Map files will be graphic files only because of the large sizes of ARCInfo files.

CDM Federal*s local administrative staff has the responsibility for maintaining the document control system. This system includes a document inventory procedure and a filing system.

Project personnel are responsible for project documents in their possession while working on a particular task. Data management protocol and procedures are discussed in the Section 8.0.

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7.0 ASSESSMENT AND OVERSIGHT

Assessments and oversight reports to management are discussed below.

7.1 ASSESSMENTS AND RESPONSE ACTIONS

Performance assessments are quantitative checks on the quality of a measurement system and may be used for analytical work. System assessments are qualitative reviews of different aspects of project work to check on the use of appropriate QC measures and the functioning of the QA system. A field and an office system assessment are currently scheduled for this project.

Response actions will be implemented on a case-by-case basis to correct quality problems. Minor response actions taken in the field to immediately correct a quality problem will be documented in the field logbook and verbally reported to the CDM Federal Project Manager. Major response actions taken in the field will be approved by the CDM Federal Project Manager and an EPA WAM prior to implementation of the change. Corrective action will be implemented in accordance with CDM Federal's Quality Procedure 8.1 Corrective Action (CDM Federal 1997b). A copy of the Corrective Action Request Form is included in Appendix E.

7.2 REPORTS TO MANAGEMENT

QA reports will be provided to CDM Federal Project Manager whenever major quality problems are encountered. Field staff will note any quality problems in a logbook or other form of documentation. CDM Federal's Project Manager will inform the QA Coordinator upon encountering quality issues that cannot be immediately corrected. Monthly QA reports will be submitted to CDM Federal*s RAC Region VIII QA Manager by the Denver QA Coordinator and the RAC Regional QA Coordinator.

Topics to be summarized regularly may include:

- C Activities and general program status;
- C Project meetings;
- C Corrective action activities;
- C Any unresolved problem; and
- C Any significant QA/QC problems not included above

8.0 DATA VALIDATION AND USABILITY

Laboratory results will be reviewed for compliance with project objectives. Data validation and evaluation are discussed in Sections 8.1 and 8.2, respectively.

8.1 VALIDATION AND VERIFICATION METHODS

Fifty percent of the first 100 sample data analyzed and reported by CDM Federal's subcontract laboratory will be validated in accordance with laboratory-specific limits, methodology, EPA CLP National Functional Guidelines for Inorganic Data Review (EPA 1994a), and/or EPA CLP National Functional Guidelines for Organic Data Review (EPA 1994b), whichever are applicable and as specified in Table 5-3. If no problems exist with validated data, 20% of the data will be validated. If there are errors, then 100 % of the data will be validated or determined by WAM. Data from EPA's Region 6 Regional and CLP laboratories will be 100 percent validated, or considered 100 percent validated prior to receipt by CDM Federal.

Data verification includes checking that results have been transferred correctly from laboratory data printouts to the laboratory report and to the EDD. During data validation, analytical data may be qualified as specified in the above-referenced guidances.

8.2 RECONCILIATION WITH USER REQUIREMENTS

8.2.1 DATA EVALUATION

One hundred percent of the analytical data from all laboratories will be evaluated for compliance with PARCC parameter criteria as described in Section 5.0 and specified in Table 5-3. After validation and evaluation, it will be determined by CDM Federal if and which data are usable for their intended purposes. During data evaluation, analytical data will not be qualified.

8.2.2 DATA REDUCTION AND TABULATION

Sample data will be maintained electronically by CDM Federal and reported in the RI Report.

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Appendices

Appendix A - Health and Safety Plan

Appendix B - Standard Operating Procedures

Appendix C - Workshop summary

Appendix D - Technical Documentation for Field Sampling Equipment

Appendix E - Field Forms

Appendix F - Contract Laboratory Program Protocol